RECREATIVE SCIENCE:

A Record and Remembrancer

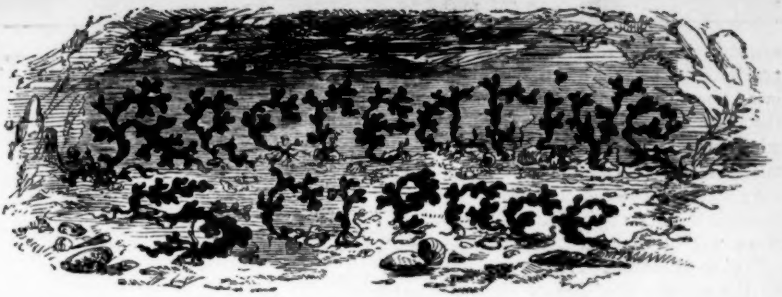
OF

INTELLECTUAL OBSERVATION.

VOLUME I.

LONDON:
GROOMBRIDGE AND SONS, PATERNOSTER ROW.
MDCCCLX.

GI



THE ENDEAVOUR.

We are of God's workmanship, created in his image, and gifted with powers to perceive and appreciate the wonders of his skill in the creation which exists around and above us. It is our privilege that we find delight in the investigation of causes and the detection of analogies, as well as in observing the distinctive features of objects in the great system of harmonies which we designate as Nature. When the visual organs have reached the limit of their ability, the eyes of the mind penetrate beneath the surface in the discovery of laws, and the imagination and the fancy blend with physical facts the graces of poetry, and so heighten and intensify enjoyments which had their beginning in the merest exercise of the senses. Science defines and classifies the results of research, brings together related facts, deduces from them general conclusions, and so lays the bases of systems of knowledge which are the pride and glory of our civilization. This is an age of invention and discovery, and the meanest affairs of life, equally with the noblest works of utility and elegance, are indebted to science, either for their origin, or at least, for the fundamental principles out of which they spring. We banish darkness from our streets by the help of the chemist; we know the day and hour at which an eclipse or occultation will occur by the predictions of the astronomer; the sun paints pictures for us on media prepared by the photographer; and places separated by distance hold converse by the instantaneous communications of the electric wire. To speak lightly of scientific studies is to ignore the entire fabric of our social life, with all its amelioration for the body and the spirit; but to stimulate the spirit of research, is to help in the onward march of human advancement, and realize the idea of the poet, that "the thoughts of men are widened by the progress of the suns."

By "Recreative Science," we understand the cultivation of the various branches of physical and mathematical inquiry in a way to afford amusement as well as instruction. Every science has its recreative features; every separate and single fact in Nature has a sunny side, and when we have solved a hard problem we may find repose and refreshment in tracing out what poetical analogies it may yet induct us to in the consideration of its recreative features. The properties of a sphere require the highest abilities of the mathematician to demonstrate, but we have the model of every sphere in a dew-drop; it is held together in the coherence of its particles by the same forces which give form and consistence to the world; and if the astronomer were to use the dew-drop as a key to the fundamental laws of

astronomy, and therefrom explain the idea of gravitation, he would be treating his subject in a recreative manner, which would engage the attention of a thousand times as many minds as would take interest in a cold mathematical formula. To enlist the sympathies of the young, and brace up the powers of mature minds in the investigation of natural phenomena, will be the object of the work now offered to the public. Truth will herein have all the vestments of beauty that of right belong to it; science, in the sternest sense of the word, will never be sacrificed to any mere literary effect; but we shall gather, as the bee does, the sweetest honey-drops from the fields of human learning, and at every step recognize, in hope and faith and love, the Source of things created, and point the mind of the student to the great Benefactor, by whose will the worlds sprung into being, and man was designed to exercise the powers of his reason in regions to which sense alone would never admit him. Nature lies before us as a panorama; let us explore, and find delight. She puts questions to us, and we may also question her; the answers may oftentimes be hard to spell, but no dreaded sphinx shall interpose when human wisdom falters. Linking the departments of knowledge together by the threads of their inevitable connection, let us help one another in our several regions of research, and so lead the way towards the perception of harmonies of which we have already the foreshadowings in the genuine poetry of science. Nature must supply the warp and woof from which the imagination is to weave the web of enchantment; if it be pleasant to gather the material, how much more so to behold the first thread, then the indication of the pattern, and at last the completed picture.

SCIENCE AND THE BOY.

THE DUTY OF THE TEACHER.

INSTIL the love and reverence which you feel,
The sweet delight in flowers and the sky,
By pictures, books: in landscapes fair and wide,
In the high mountains and the boundless sea.
Teach him to love all these; moreover, name
The petals of each flow'ret, class each shell:—
Mark well the wondrous fashion of God's work, in
Bird, animal, and insect.
His young heart
Will pulse and throb with a most holy awe
When he shall mark the infinite wisdom shown
In each and all, an atom or a globe,
Proceeding from God's hand; when he shall know
That not a feather stirs beyond its place,
That not a beauty but still has a use—
That even in the roughest, hardest things
Strange glories lie; that in the wing o' the gnat,
The skin of snake, or eye of crawling toad,
Such clouds of glorious colour are contained,
That the skilled pencil and the cunning brain
Of man can scarcely picture; the rough shell,
Touched with Art's polish, brightly glows and glads
Each eye that sees it, and a shred of wood
Holds in its little space most wondrous forms.
* * * * When this glimpse
Thou hast given him of this world we have and hold,
Bring forth those instruments by Science made
To show the upper and the lower worlds,
And mark the two infinities of each.
Peer through the TELESCOPE, world-systems show,
And tell what various knowledge testifies;
Of star-globes floating in the abyss of blue;
Reason of worlds in worlds; of suns that gem
The sky like gold-dust sprinkled on a robe,
But yet *are* SUNS. Each step you farther go
Unveil new wonders, till he shall fall down,
Knowing his infinite smallness, and gasp out
His humble prayer to Him who made them all!

And now the MICROSCOPE produce, and show
Design and glory in a filmy wing,
That plumes more gorgeous than the ostrich bears
Deck the poor moth; the house-fly has a foot
Fitted with instrument so wisely made,
That man, but in the gray age o' the world,
Found comprehension for it.
Show him how prodigal of work God is,
How every small ephemeris sets forth
Purpose and science, if born but to die,
As we in our weak knowledge still must deem.
Show him the myriads which live within
A drop of water; that Intelligence
Creates and orders, and still cares for each;
And then his heart will throb and bound again,
Knowing his greatness, and thus led to GOD
By steps hewn in the Infinite Unknown,
But not uncertain, he will wisely pray—
Reverence himself, and love his neighbour too.—Φ.

THE PLANETS.

To no other subject can the oft-repeated assertion of "We live in an age of discovery" be more aptly applied, than to the glorious science of Astronomy. Whereas in the school-days of our fathers, and indeed of most of us, the number of known planets was only eleven, the last fourteen years have increased the list to sixty-four. It is now difficult for any but the astronomer to keep pace with these rapid discoveries; our most recent works on the subject are almost sure to be half a dozen planets in arrear with their information, for even whilst the sheets are passing through the press, a number of diligent observers are still exerting themselves, in order to add new worlds to our solar system.

It may be asked, how is it that the nineteenth century has done so much in this particular branch of astronomy? Many great names had preceded those of the present time, many diligent observers lived and flourished in the eighteenth century, yet why had they overlooked so many planets?

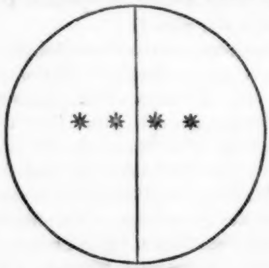


FIG. 1.

The systematic plan now adopted of sweeping the heavens with large telescopes, and mapping down all the stars in the neighbourhood of the ecliptic, has mainly contributed to these planetary discoveries. All the planets are situated in a small zone of the heavens near the ecliptic, so that if such stars are mapped down, and the same region of space is again returned to, and carefully compared with the previous maps, it is quite evident that if a certain map had contained ten stars, and on sweeping over the same space a few months later, eleven were found, a new comer must have travelled into this map. An hour's observation with the double-image micrometer is sufficient time to enable the astronomer to ascertain whether this additional body be a planet or a star.

In short, to make this assertion clear, the double-image micrometer, from its peculiar construction, shows two images of the same object; and as a planet moves much more rapidly than a star, if the speed of the new body be compared with one of those previously mapped down, an hour's time will amply prove whether both bodies are moving with an equal speed.

The two images of the new body, and the two images of the body in comparison with it, are, by means of a rackwork adjustment, made to show four objects in one and the

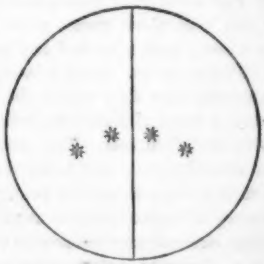


FIG. 2.

same straight line, as in Fig. 1. Now, if both the objects are stars, their relative positions will remain unaltered, whilst if one is a planet, they may possibly show themselves as in Fig. 2. Having previously read off the vernier of the position micrometer when the four images were in a straight

line, and again in an hour's interval, after moving the screw so as to again place them in the same straight line, it follows, that the redaings of the vernier will give the exact movement which has taken place during that hour.

Sometimes the number of stars in a certain map will be found to have diminished, and then it is evident that a planet had been previously mapped down as a star, and if this stranger cannot be detected in an adjacent map, it will be lost for a time at all events. In this manner, and also owing to clouds obscuring the sky before the requisite verification could be accomplished, and the heavens remaining overcast for several weeks afterwards, some planets have eluded the vigilance of observers.

To the equatorial telescope we are indebted for all these discoveries, for it is absolutely requisite that we should be able to turn to any particular portion of the heavens that we may desire, in order to enable us to return to the required spot. This telescope moving on circles of right ascension and declination, accurately divided into degrees, minutes, and seconds of space, and having dials which will show these positions, it becomes an easy matter to find any required portion of the heavens. Such telescopes are more numerous than they used to be, and in the hands of a corps of observers, both public and private, and all directing their energies in the same direction, it is not to be wondered at, that such labours should be rewarded by the discovery of bodies hitherto unknown.

Another circumstance remains to be mentioned, *i. e.*, formerly, astronomers were satisfied if they constructed maps of the stars down to the 6th magnitude, now, such maps descend to the 10th, 11th, and 12th magnitudes; and as it is in the 9th, 10th, and 11th magnitudes that the bulk of these planets are classed, we can see a sufficient reason why so many planets have been previously overlooked.

There is a singular history with regard to Goldschmidt's planet Daphne, resulting in the discovery of another new planet. Unfavourable weather setting in soon after its discovery, prevented a sufficient number of observations being made in order to ascertain its proper orbit; therefore this planet was lost, and its discoverer set about the task of rediscovering it. On the 9th of September, 1857, Goldschmidt conceived that he had found it, but Schubert has since proved that the object seen on that date could not be Daphne, but a *new planet*. A delicacy seems to exist between Schubert and Goldschmidt as to whom the discovery should be ascribed, the latter having discovered it, yet thought it to be Daphne, whilst the former, from calculation, showed that it could not be that planet. Hitherto it has received no other name than Pseudo-Daphne, to distinguish it from the true Daphne.

With the exception of Neptune, the whole of the new planets are what astronomers have termed Asteroids, or minor planets, and their discovery was in the first instance to be ascribed to Professor Bode, of Berlin, who, in the year 1772, ventured to predict the discovery of a new planet.

That well-known astronomer became aware of the fact that a numerical relation existed between the distances of the planets from each other and from the sun. If we take the numbers 0, 3, 6, 12, 24, 48, 96, 192, and 384, and add 4 to each of them, we shall have 4, 7, 10, 16, 28, 52, 100, 196, and 388 expressing the order and proportion of the distances of the planets from the sun. Thus Professor Bode found that 4 represented Mercury, 7 Venus, 10 the Earth, 16 Mars, 52 Jupiter, and 100 Saturn, and that this numerical law held good with all the planets, with the solitary exception of a break between 16 (Mars) and 52 (Jupiter); there wanted a planet which should be expressed by 28, and so satisfied was Professor Bode that one existed, that he boldly came forward, and predicted it.

On the 1st of January, 1801, Piazzi discovered the planet Ceres, and the gap was filled up; yet, strange to say, in 1802, Dr. Olbers discovered another (Pallas) at the same mean distance from the sun as Ceres; and in 1803 Harding detected Juno, and in 1807 Dr. Olbers found Vesta; all of which can be represented by the number 28. Astronomers at length began to argue that, as these planets were very small, probably others would be discovered, which, collectively, would be equal in a somewhat similar bulk to the other planets. However, no further discoveries resulted until the year 1845, when Hencke, after many years' diligent observation, detected Astræa; since which date planet after planet has been added to this list, until it has rapidly become swollen to sixty-four, fifty-six of which constitute a ring of planets, whose mean distance from the sun may be represented by 28, and to this number no doubt others will be added.

The numerical law of which we have been speaking, gave promise of other bodies being found exterior to Saturn; 196 would represent the distance from the sun of a planet exterior to Saturn, and such a planet (Uranus) was detected by Sir William Herschel; and again, 388 would represent another still further removed from the sun.

Owing to the power of gravitation, planetary bodies exert an influence over each other; thus, a body can be pulled *outwards* if under the influence of a body *exterior* to it, or *inwards* if of one *interior* to it. Now Uranus was observed to receive this *outward* influence, and, consequently, a planet exterior to it was conceived to exist. A dozen years ago the independent abstruse calculations of M. Le Verrier, a French, and Mr. Adams, an English mathematician, based on these perturbations, were confirmed by the discovery of the planet Neptune.

Should another planet exist, still more remote, at a numerical distance represented by 772, calculation may again be the means of finding a body so far removed from the sun; and thus the solar system may be again expanded considerably beyond the bounds which it is now shown to occupy.

We are apt to conceive that planets move around the sun in almost circular paths, and indeed they would do so, were it not for the influence exerted upon them by other bodies. Supposing that no influence were exerted upon a planet, its motion would be represented by Fig. 3. Yet, as this is not the case, the annexed diagram, Fig. 4, of a planet's orbit, acted upon by an *exterior* planet in the one portion, and by an *interior* planet in another portion of the orbit, will give some idea of the effect produced. It is necessary to understand this, in order to be conversant with the effects produced by one body upon another—effects which, studied by our best astronomers, have been

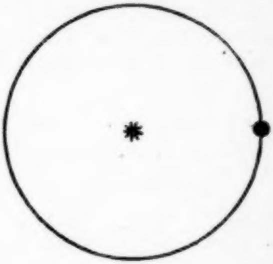


Fig. 3.

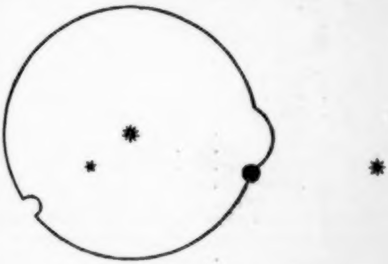


Fig. 4.

the means of bringing to light bodies whose existence was previously unknown.

Speaking of the mean distances of the asteroids from the sun, *Flora* (Hind's) is the nearest, viz., 209,788,000 miles, with a period of 1193 days. *Ariadne* (Pogson's) was formerly considered to hold this post of honour, but the latest elements by Weir give its mean distance as 210,022,000 miles, with a period of 1195 days. *Hygeia* (Gasperis') is the most remote, viz., 301,324,000 miles, with a period of 2054 days. The eccentricity of the orbit may, however, in several cases, take a planet much nearer the sun than Flora's mean distance, or when in aphelion, much further off than the mean distance of Hygeia. For instance, Melpomene's perihelion, and Themis's aphelion may be considered as the present known limits of the asteroidal region. Of the asteroids, *Vesta* is the brightest, and *Atalanta* and *Hestia* the faintest.

The following is a list of the planets of our solar system, together with the names of the discoverers, the place and date, and the number each astronomer has discovered:—

Sign.	Names of the Planets.	Date of Discovery.	Discoverer.	Place of Discovery.	Number each Observer has discovered.
—	Mercury	Known to the Ancients	—	—	—
—	Venus	Do.	—	—	—
—	The Earth (or Tellus)	Do.	—	—	—
—	Mars	Do.	—	—	—
1	Ceres	1801, January 1	Piazzi	Palermo	1
2	Pallas	1802, March 28	Olbers	Bremen	1
3	Juno	1804, September 1	Harding	Lilienthal	1
4	Vesta	1807, March 29	Olbers	Bremen	2
5	Astræa	1845, December 8	Hencke	Driesen	1
6	Hebe	1847, July 1	Hencke	Driesen	2
7	Iris	1847, August 13	Hind	London	1
8	Flora	1847, October 18	Hind	London	2
9	Metis	1848, April 25	Graham	Markree	1
10	Hygeia	1849, April 12	Gasperis	Naples	1
11	Parthenope	1850, May 11	Gasperis	Naples	2
12	Victoria	1850, September 13	Hind	London	3
13	Egeria	1850, November 2	Gasperis	Naples	3
14	Irene*	1851, May 19	Hind	London	4
15	Eunomia	1851, July 29	Gasperis	Naples	4
16	Psyche	1852, March 17	Gasperis	Naples	5
17	Thetis	1852, April 17	Luther	Bilk	1
18	Melpomene	1852, June 24	Hind	London	5
19	Fortuna	1852, August 22	Hind	London	6
20	Massilia †	1852, September 19	Gasperis	Naples	6
21	Lutetia	1852, November 15	Goldschmidt	Paris	1
22	Calliope	1852, November 16	Hind	London	7
23	Thalia	1852, December 15	Hind	London	8
24	Themis	1853, April 5	Gasperis	Naples	7
25	Phocea	1853, April 6	Chacornac	Marseilles	1
26	Proserpine	1853, May 5	Luther	Bilk	2
27	Euterpe	1853, November 8	Hind	London	9
28	Bellona	1854, March 1	Luther	Bilk	3
29	Amphitrite ‡	1854, March 1	Marth	London	1
30	Urania	1854, July 22	Hind	London	10
31	Euphrosyne	1854, September 1	Ferguson	Washington	1
32	Pomona	1854, October 26	Goldschmidt	Paris	2

* Irene was independently discovered four days later, by Gasperis.
† Massilia one day later, by Chacornac.
‡ Amphitrite one day later, by Pogson, and two days later, by Chacornac.

Sign.	Names of the Planets.	Date of Discovery.	Discoverer.	Place of Discovery.	Number each Observer has discovered.
33	Polyhymnia	1854, October 28	Chacornac	Paris	2
34	Circe	1855, April 6	Chacornac	Paris	3
35	Leucothea	1855, April 19	Luther	Bilk	4
36	Atalanta	1855, October 5	Goldschmidt	Paris	3
37	Fides	1855, October 5	Luther	Bilk	5
38	Leda	1856, January 12	Chacornac	Paris	4
39	Lætitia	1856, February 8	Chacornac	Paris	5
40	Harmonia	1856, March 31	Goldschmidt	Paris	4
41	Daphne	1856, May 22	Goldschmidt	Paris	5
42	Isis	1856, May 23	Pogson	Oxford	1
43	Ariadne	1857, April 15	Pogson	Oxford	2
44	Nysa	1857, May 27	Goldschmidt	Paris	6
45	Eugenia	1857, June 28	Goldschmidt	Paris	7
46	Hestia	1857, August 16	Pogson	Oxford	3
47	Aglaia	1857, September 15	Luther	Bilk	6
48	Doris	1857, September 19	Goldschmidt	Paris	8
49	Pales	1857, September 19	Goldschmidt	Paris	9
50	Virginia*	1857, October 4	Ferguson	Washington	2
51	Nemausa	1858, January 22	Laurent	Nismes	1
52	Europa	1858, February 6	Goldschmidt	Paris	10
53	Calypso	1858, April 8	Luther	Bilk	7
54	Alexandra	1858, September 11	Goldschmidt	Paris	11
55	Pandora	1858, September 11	Searle	Albany	1
56	Pseudo-Daphne†	1857, September 9	Schubert	—	1
—	Jupiter	Known to the Ancients	—	—	—
—	Saturn	Do.	—	—	—
—	Uranus	1781	W. Herschel	London	1
—	Neptune‡	1846	Le Verrier	Paris	1

Of the small planets, nine were discovered in 1857, eight in 1852, six in 1854, five in 1856, and five in 1858, four in 1853, and four in 1855, three in 1847, and three in 1850, two in 1851, and one in 1801, 1802, 1804, 1807, 1848, and 1849. Goldschmidt lays claim to the discovery of eleven, Hind of ten, Gasperis and Luther of seven each, Chacornac of five, Pogson of three, Olbers, Hencke and Ferguson of two each, and Piazzi, Harding, Graham, Marth, Laurent, Searle, and Schubert of one each.

Highfield House Observatory, Nottingham. E. J. Lowe.

HOW TO GATHER DIATOMS.

The Diatomaceæ being objects of interest to most persons possessed of a microscope, a few plain directions for gathering them may be appropriate to a time when all who can get a brief holiday, are either away, or going to the seaside, or wild inland districts, where the finest are to be had.

With a general understanding that they all grow in water, fresh, salt, or a mixture of the two, the materials required for collecting are:—From one to two dozen of "Preston Salts" bottles with corks; a long light stick, for which the two thick joints of a cheap fishing-rod answer well, the hollow serving

* Virginia, fifteen days later, by Luther.

† Pseudo-Daphne, discovered by Goldschmidt, September 9th, 1857, yet thought by him to be Daphne. Schubert, from calculation, proved it could not be Daphne. Yet neither astronomer has as yet named it.

‡ Neptune, independently discovered from calculation by Le Verrier and Adams, and found telescopically by Dr. Galle.

for the attachment of—1st, a curved cutting-hook, like a reaping-hook in miniature; 2nd, a small muslin net; and 3rd, an old spoon. A good Coddington lens and slip of glass, or a "live-box," may help in some cases to a knowledge on the spot of what we have found; but the objects of our search are so minute, that not much can be done in this way in the field.

How can I tell what to look for? the youthful student may say. The answer to which is, that in mass when growing, they might be compared to brown jelly, coating other water-plants, or stones, or the surface of mud at the bottom of the water.

Spring and autumn are the most favourable periods for them. Suppose we are out for the day on a Diatom-hunt, our pockets stored with as many bottles as they will hold, and the other necessary appliances with us: we make for a stream and go up its banks; covering the stems and blades of grass over which water flows, we may see this brown jelly-like material, which is best got by gently cutting off some of the blades of the grass to which it is attached, and putting them into a bottle, which is to be filled with water to prevent shaking. Cymbellas and Gomphonemas are what we shall probably have got. The white water-crowfoot, and grasses growing towards the centre of the stream, may be thickly covered at their floating tips with brown waving threads; cut off a portion with the hook, and transfer dexterously to another bottle; we shall find *Melosiras* and *Synedras*. In small tributaries to the main stream we may be fortunate enough to obtain *Campylodiscus costatus* and *C. spiralis*, princes of the tribe, and *Surirellas*, or the exquisite *Meridion*. Boggy pools yield some elegant species, as *Eunotias*, *Himantidia*, not elsewhere to be had; and wells of spring-water, *Tabellarias* and some *Diatomas*. In shallow streams stones may be picked from the bottom containing interesting species; mountain torrents yield *Gomphonema geminatum*, the finest of its genus, and the curious *Tetracyclus lacustris*. *Encyonema* may be met with where water runs rapidly and constantly, as over a dam.

At the seaside we shall meet very different kinds; as, growing on large or small sea-weeds, the beautiful flag-like *Achnanthes* and *Striatella*, the *Rhabdonemas* and *Grammatophoras*, fine *Melosiras*, and small arborescent forms, from one to two inches in length—these are *Schizonemas*. Also, if very fortunate, *Amphitetras*, *Biddulphia pulchella* and the *Isthmias*. Along the sands of quiet bays, at about the line of half-tide, in furrows constantly wet, many interesting species may be found. To get these in a state fit for carrying home, the yellowish facing of the sand should be scraped up with a spoon, and a quantity put into a

half-pint bottle, to be filled with sea-water; after a good shake, the sand will, in a few seconds, fall to the bottom, and the water with Diatoms is to be poured off, when they will settle as a sediment, which latter should be put into the smaller bottles.

Brackish water furnishes *Biddulphia aurita*, *Melosira nummuloides*, and fine *Pleurosigmas* and *Naviculas*.

The gathering from each place should be put into a separate bottle, and it is well to put in a slip of paper with the cork, on which, with lead pencil, the locality may be noted. Extreme care in washing bottles and corks, previous to putting by for another occasion, is essential.

On getting home we may seem to have brought back nothing but bottles of dirty water; this should be emptied into saucers, putting the named slip by each, and with a few hours' exposure to sunlight the Diatoms will be found in a beautifully clean condition, on the surface of the mud, and may then be carefully removed for examination, and preservation, if thought desirable. Of these we must treat on a future occasion.

In addition to those above-named it may be well just to *indicate* other sources, some of which are hardly accessible to dwellers in large towns, except at the annual holiday time.

Such are the stomachs of shell-fish fresh from the sea, oysters and scallops especially; of crabs and lobsters, of haddock, cod, and the different kinds of flat fish; whence very fine kinds not otherwise obtainable, habitants of the deep sea, may be procured. It is essential that the shell-fish should be fresh from their oozy beds, since the ceaseless currents produced by the action of the cilia (microscopic hair-like processes) with which they are furnished, rapidly wash the Diatoms away, and the result of much patient search may, from inattention to this circumstance, prove a blank. A large infusorial animalcule, the Noctiluca, cause of much of the phosphorescence of the sea, proves to be a capital Diatom-gatherer.

Deposits on the shores and at the bottom of lakes, now or previously existent at such spots; of this many instances have been recorded, in which complete strata have been formed from the valves of Diatomaceæ, that lived and died on the spots where their remains occur.

Ehrenberg has described a remarkable species (*Orthosira mirabilis*), as inhabiting moss growing on trees. Our distinguished countryman Mr. Ralfs started one day in quest of this, and bringing home a quantity of the mossy coatings of trees growing in the neighbourhood of Penzance, Cornwall, his place of residence, found on his return that he had really got this Diatom in abundance. An attempt has been made to explain away the singular fact of a Diatom inhabiting such a locality, by the hypothesis that the examples found had been blown there by the winds. But this seems a purely gratuitous supposition, since it is perfectly well known that moss growing in alpine localities, where it is moistened with mists and the perpetual trickling of springs, furnishes a home for some beautiful species of the tribe; the occurrence of Diatomaceæ in fragments of earth adhering to the roots of dried plants obtained from various parts of the world, shows that Diatoms do *live* in moist earth. We have only to suppose that the species in question is endowed with an unusual power of retaining its vitality during periods of drought, and the difficulty vanishes. If our readers will take up this question, it may soon be solved; they will find it one of exceeding interest, and furnish valuable aid to the cause of science. The words used in the definition, were in effect that they *generally* lived in water, but certainly not at all times, invariably.

TUFFEN WEST.

WAYSIDE WEEDS AND THEIR TEACHINGS.

IN SIX HANDFULS.

"There's a dance of leaves in that aspen bower,
There's a titter of winds in that beechen tree,
There's a smile on the fruit, and a smile on the flower,
And a laugh from the brook that runs to the sea."

The Gladness of Nature.—BRYANT.

THE science of plants, Botany, has this great advantage over every other department of natural history, that its objects are not only most readily accessible, but that they have been familiar to most of us from childhood. The first steps of the entomologist, the geologist, or the mineralogist, are made, as it were, into a new world, wherein all is strange and unknown—to the novice we might say chaotic—but who does not know the first easy paths which guide us into Flora's realms? Are they not to every child bordered and carpeted with daisies, and buttercups, and sweet-scented violets? Have we not picked in them chickweed and groundsel for our favourite birds, and looked at the scarlet poppies somewhat doubtfully as poisonous, putting them under the same anathema as "hemlock," which, however, was often not hemlock at all? Then, again, are not these paths overhung with the wild rose and honeysuckle for our summer shade? And when, after long absence, it may be, in the smoky town or in some foreign clime, we return to retread the paths again, see these old familiar faces, do we not know their names as well as we do our own?

"The cowslip, crocus, columbine,
The violet and the snowdrop fine,
The orchis 'neath the hawthorn-tree,
The blue-bell and anemone,
The wild rose, eglantine, and daisy."

We know them all, and many another, without any teaching.

Truly this name-knowledge is no despicable foundation for our future botanical education—a far better one than we could find for any other science; sounder, too, for it has not only a place in the head but in the heart; dull and dead must that heart be, that greets not warmly the old friends of our first toddling days.

On this foundation we purpose to build, and thus to avoid what so often proves a first and formidable difficulty when subjects are dealt with of which the learners have no previous knowledge. We mean to take, both for text and illustration, the commonest wayside weeds and flowers familiar to all, and we mean them, being their own interpreters, to tell us a great deal. We will try whether they cannot outline for us, if we may so speak, the plan of the flowery world, and whether we cannot gather from their simple teachings some idea of the great design, in accordance with which the vegetable kingdom is constructed and arranged. It may be that many will be content with this, but should some desire to go farther, and to gain more knowledge of the numberless forms of vegetable beauty and structure to be met with amid the native plants of our own land, and still more strikingly, perhaps, amid those of other latitudes, they will find the foundation begun upon our common "Wayside Weeds," a solid because a practical one.

We call them common, and, in one sense, they are so—the sense in which we have chosen them for illustration; but common are they in no others, for as surely and as well as the most gorgeous exotic, do each and all show forth the goodness, the wisdom, and the power of that great Creator, whose

"Steps are beauty, and his presence light."

A few words as to our arrangement.

Each of our prospective handfuls is made to embrace a certain section of plants, related to each other in the natural classification. It is by no means requisite that all the plants named should be gathered at once, and, indeed, as they often blow at different periods of the year, this would be impossible; but enough may always be found to illustrate our text, not only as regards the classification of the flowers, but with reference to the other botanical lessons which have been appended to each section. A general summing up will probably gather our handfuls into one. If many common wayside flowers are familiar, and deck our first early wanderings in the fields, no less so are the fruits which succeed; heps and haws, crab apples, hazel nuts, sloes, blackberries, strawberries, and many another, for

> "Blackberries so mawkish now,
> Were finely flavoured then."

He or she must be veritably town born and bred, if they do not know these the common fruits of childhood's garden, and thus, presuming upon the knowledge, we will add our baskets of hedge-row fruits to our handfuls of wayside flowers.

Handful I.—Flowers in Many Pieces, "Many-Petaled."

Weeds are flowers—The Handful—Poppies—Buttercups and Marsh Marygold—Wallflower and Lady's Smock—Violets—Lychnis—Stitchwort—Chickweed and Geranium—Petals or flower-leaves—How attached—Their shape and parts—A corolla—Stamens, their site, and how distinguished—Pistil or central organ; its forms—Calyx; its forms, etc.—Position of parts of flowers in handful the first—Likeness and Difference—The Buttercups and Crowfoots—Poppy characters—Wallflower and the Cruciforms—Regular Flowers—Starwort and Geranium—Summary.

Let us see what we have got. Weeds every one of them! Weeds we all know them to be, but flowers they are as well; we will therefore give them the name indifferently, weeds or flowers, as it may be. Poppies in their red, from the corn-field or wayside; bright shining buttercups from the meadows, with their magnificent cousin the marsh marygold; a stray wallflower from the old castle wall, or garden if you will, for it is a true British wildling; lady's smock; and a charlock—the yellow flower you always call wild mustard—or, if you like it better, a water-cress. Do not forget our wee blue friends the sweet violets, for, except the fragrant wallflower, they are the only scented blossoms in our bundle. Add to these a scarlet lychnis; one of the brilliant white stitchworts, or starworts, a better name, from under the May hedgerow, and with it its little sister the common chickweed, and the mouse-ear, like a hairy chickweed, though it is not one; lastly, put in a common wayside geranium, and we have handful No. 1, from which we are to learn a whole heap of botanical lore.

Our paper is headed "Many-pieced, or many-petaled flowers." Unbotanical people call the pieces of a flower "leaves;" but as the same term is applied to the leaves of the plant generally, the pretty term "petal" is more convenient; we therefore, for the future, shall always speak of petals, albeit it gives our first initiament into botanical terms. Take all the flowers of our handful, or as many of them as you have got, and look at these petals; pull them off if you possess a good show of specimens, and you will see that they are all unconnected with one another. First comes the bright red poppy, with its four petals (Fig. 1), all attached

Fig. 1.—Petal of Common Poppy.

beneath the projection in the centre of the flower (Fig. 6).

Put down the poppy and take up the buttercups, all you have gathered (Figs. 2, 3, 4),

FIG. 2.—The Bulbous-rooted Ranunculus, back view. *a*, petals of expanded blossoms; *b*, reflexed calyx, or flower-cup; *c*, blossom half expanded, the flower-cup not yet turned back; *d*, peduncle, or flower-stem; *e*, bract or flower-leaf.

and, if it chances to be in the handful, the marsh marygold, which probably some of

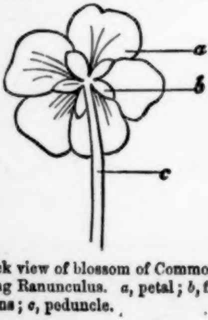


FIG. 3.—Back view of blossom of Common Buttercup, or Creeping Ranunculus. *a*, petal; *b*, flower-cup, in five sections; *c*, peduncle.

my readers know as the "May blob." Any and all of these have, as you see, five petals

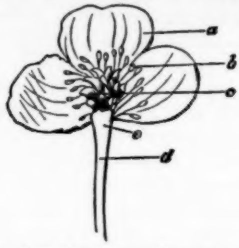


FIG. 4.—Section of Buttercup blossom. *a*, petal; *b*, stamens; *c*, pistils; *d*, flower-stem, or peduncle; *e*, receptacle.

(Fig. 3), and though the central organ (Fig. 4 *c*) is not exactly similar to that of

FIG. 5.—Buttercup petals.

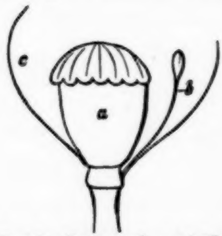


FIG. 6.—Seed-vessel or pistil of Common Poppy, *a*; *b*, stamen; *c*, part of petal.

the poppy (Fig. 6), you may yet observe a likeness in the attachments of the petals.

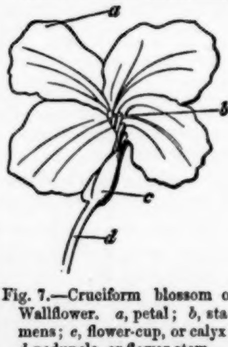


Fig. 7.—Cruciform blossom of Wallflower. *a*, petal; *b*, stamens; *c*, flower-cup, or calyx; *d*, peduncle, or flower-stem.

FIG. 8.—Petal of Wallflower. *a*, limb; *b*, claw.

Take the wallflower, another of your bunch of blossoms; its petals are very different from the petals of the poppy or the butter-cups. The latter, you have already seen, are oval and pointed at the base (Figs. 1, 5); in the instance before us they are prolonged into the *claw* (Fig. 7 *b*), in contradistinction to the broad portion or *limb*. A somewhat similar petal you find in the scarlet or white

FIG. 9.—Blossom of Lychnis, with pistils only. *a*, petal; *b*, pistils; *c*, calyx.

FIG. 10.—Petal of Lychnis. *a*, limb; *b*, claw.

lychnis (Figs. 9, 10), although in other respects it is diverse. Clawed, likewise, but less distinctly so, are the five petals of the wild geranium (Figs. 11, 12). However, there

FIG. 11.—Blossom of Common Wild Geranium (Herb Robert). *a*, petals; *b*, calyx.

FIG. 12.—Petal of Wild Geranium. *a*, limb; *b*, claw.

is no occasion to go over in succession every plant in our handful; you can do that alone, and pulling off the petals compare their varied shape and cuttings, as well as their attachments and numbers; having done this, you will have gained some knowledge of one of the divisions of the kingdom of botany —the many-petaled (*polypetalous*) flowers, with their petals attached beneath what botanists call the pistil, but which, till we have formally introduced it, we must call the central organ of the flower. In the majority of flowers, however—we shall see, hereafter, not in all—between the central organ and the petals we have just been examining, there is a greater or less number of small bodies, little heads supported on slender stems (Fig 13). In the poppy and

FIG. 13.—Stamen, magnified.

FIG. 14.—Organs of Wallflower. *a*, stamens; *b*, pistil.

ranunculus, these little bodies are very numerous, almost too numerous to count easily (Fig. 4); but look into your wallflower, you have no difficulty there, for six is all you can find (Fig. 14), only you wonder to see that, in every blossom you examine, two are shorter than the others. Put down the wallflower, and take up your wild mustard

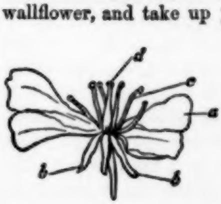


FIG. 15.—Blossom of Common Charlock. *a*, petal; *b*, *b*, calyx sepals; *c*, stamen; *d*, pistil.

FIG. 16.—Calyx or flower-cup of Common Lychnis. *a*, calyx; *b*, stamens.

(Fig 15), or your water-cress, and you will find the same thing. Be sure you have got an established fact, and do not forget it. Take your lychnis, a red one, however, and you will find ten of these little bodies (Fig. 16); but, probably, no central organ. Try to count them in the violet, there are only five; but you have some difficulty, for they all adhere together, and two of them have little spurs superadded, which might confuse a beginner. These little bodies, which we have just been examining, are called the *stamens*, but what they are, what is their structure and functions, we must tell in a future page, only remark that, *in the flowers you have examined*, their attachment, in the composition of the blossom, is the same as that of the petals. Put aside the stamens, or pull them off, and we come, at length, to our friend in the centre, whose name we have already let out—the pistil (Figs. 4, 6, 17, 18), and a very varied

Fig. 17.—Pistil of Lychnis. *a*, ovary; *b*, styles; *c*, receptacle.

Fig. 18.—Seed-vessel and pistils of Common Stichwort.

piece of structure it seems, judging by the specimens. In the poppy it is short, round, and marked or rayed on the top; in the buttercup it seems made up of a number of projecting pieces; in the wallflower, it is prolonged; in the lychnis, rounded and oval, crowned by the thread-like styles. Observe, in all these cases, it rises from a little seat or *receptacle*, to which are attached the petals and the stamens. You will not, however, have advanced far in your botanical studies before you discover that this single mode of attachment is by no means universal; but one thing you will find constant, the relative positions of the organs of the flower, which we have just gone over. Petals, or *corolla*, as the petals are called collectively, stamens and pistils, are always placed in the same order, one within the other. They may not all be present; in some blossoms they are never all present together, but you will never find stamens outside the petals, or pistil outside the stamens.

Spencer Thomson, M.D.

(*To be continued.*)

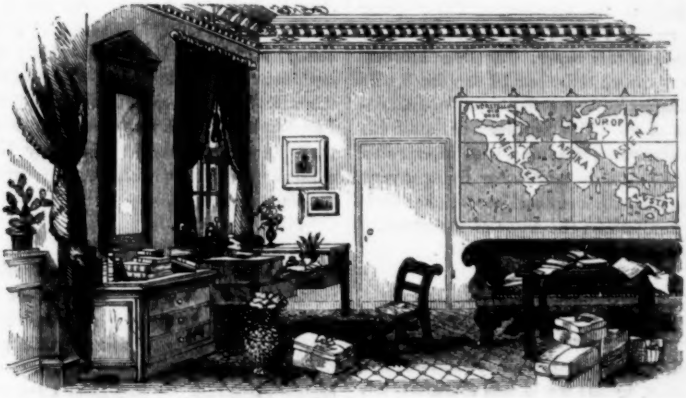
TAME FISHES.

Procure a twenty-inch bell-glass; set it on a stand in a north window; lay down a bed of pebbles; plant a few tufts of water-weed (*Anacharis*), and fill with river water. After it has stood a few days, procure three small Prussian carp and six minnows. Have no gold-fish, no molluscs, and no rockwork. Allow the conferva to grow on the glass, except on the side next the room, which keep clean.

Every morning and evening feed the fishes with very small earthworms, gentles, or small caterpillars, and be careful to drop them in only one or two at a time, so that none be left to foul the water. Frequently sit beside the vessel, and watch the gambols of your pets; now and then tap on the front of the glass with your finger-nail, and so accustom them to your presence. By degrees they will get bold and playful; be sure to tap with your finger-nail before you feed them, and instead of dropping the food in for them to take it in their own way, hold a worm between your fingers at the surface, and one of the boldest of the minnows will snatch it away playfully. Persevere, and you may call them together by tapping on the glass, and have them feed from your fingers, and even submit to be tickled on the back in quiet enjoyment of your friendship and familiarity. H.

HUMBOLDT.

IN TWO PARTS.—PART I.



HIS STUDY.

BIRTH AND EARLY LIFE.

It is well to be reminded, in the midst of the rejoicings for victory in one nation and the moanings of defeat in another, that the great march of science still continues across the noise of smoke and wailing, that the passage of knowledge is uninterrupted either by blockade or siege. Nothing will do this for us more thoroughly than the lives of great and wise men, of the soldiers of science, of the pioneers of progress, of the true apostles of peace. By their lives we shall be reminded that

> "We may make *our* lives sublime,"

and, to continue the quotation,

> "Departing leave behind us
> Footprints on the sands of Time;"

footprints which will be assurances to those who follow, that great men have been before them, who have turned from the hurry, bustle, noise, and smoke of glory; the over-excitement and maddening rush for gold, the scramble for honours, or chicanery of place, to that quieter, calmer, better path of daily labour and daily worship, of patient investigation and pure thought, which rises, like calm incense in an evening sky, towards the throne of the All-Knower; which abounds in love to our brothers, since it abounds in benefits conferred on them; which eases and soothes men's minds disturbed by angry passions, and is in its intensity a kind of noble faith, even in the Pagan philosopher, since by it he venerates and worships the Creator in his works, and looks through Nature up to Nature's God.

There is no "life" of the present day which will better illustrate the foregoing than that of Frederick Henry Alexander, Baron Humboldt, known since his elevation to the peerage of humanity, simply by the last name. Humboldt's mother, a woman of great intellectual endowments and some beauty, was the widow of Baron Holwede when she attracted the attention and love of Major Humboldt, an aide-de-camp to the Duke of Brunswick, during the seven years' war. She did not long remain a widow.

She entrusted herself, her fortune, and one son by her first marriage, to the aide-de-camp, and on the 22nd of June, 1767, at Potsdam, gave birth to Charles William Humboldt, and at the chateau of Tegel, near Berlin, on the 14th of September, 1769, to the subject of this paper. The elder brother, Charles, grew up to be one of the finest wits in Germany; he was a poet, critic, philologist, statesman. His brother was, after his kind, a statesman too, one who interpreted the laws of Nature, and, after living a very long life, full of honour and renown, has died, leaving behind him the name of the greatest naturalist and *savant* of his country.

EDUCATION—THE FIRST IMPULSE.

The two boys were but young when they lost their father, and their education and introduction to the world was therefore left entirely to Madame Humboldt. This lady had entrusted one Joachim Campe in the education of her eldest son. The master was then well known as the author of "The Young Crusoe;" now he is forgotten, save when connected with his pupils, for it is the property of great men to render all around them celebrated. Various was the instruction given to the young Humboldts. Besides Campe, Christian Kunth should be mentioned amongst Humboldt's teachers. From their father's chateau the two boys went to Berlin, Frankfort-on-the-Oder, and, lastly, to Göttingen.

It was at the last place, whilst his brother was writing poetry, and was filled with all the enthusiasm of the ardent spirits of the time in regard to that event, the French Revolution—an event which, by the way, disappointed and horrified all its admirers—that Alexander happily met a gentleman of some notoriety, who had been round the world with Captain Cook. The glowing narration of the beauties of Nature, which Humboldt heard from the mouth of this man, George Forster, fired him with the first desire to become a naturalist. He had made a *debut* in literature. He came out with something very scientific, something excessively learned, the result of cramming. He wrote absolutely "On the Textile Fabrics of the Grecians," about which he could have known nothing. Henceforward he was to abandon "textile fabrics," and to inquire not how Penelope's petticoat was spun, but how God made this earth, and in what way He had clothed the plains with verdure and the forests with leaves.

GEORGE FORSTER.

To this George Forster, in truth, the world should give credit for much of Humboldt's glory. It is a great thing to have given the first impulse to a youthful genius. Man, or book, which does it cannot be too highly estimated. "Robinson Crusoe" has filled our navy, rendered our merchants famous, has given a seaward impulse to the nation which other people seek in vain to possess. So old George Forster, gossiping over his modest can of Bavarian beer about his voyage with the great Captain Cook, sets that in a flame which eighty years cannot quench, and which in its progress, like a great fire on a high hill, casts its reflection far and wide.

With George Forster, Humboldt made his first scientific tour. He travelled to England and to France, examining the earth, its strata, and the mineral productions of each country. He was also actuated by a strange desire to go to the new world, and to observe the life of a savage, to mark how far it differed from that of civilized man, but that desire was not yet to be gratified. With the advice and assistance of Forster, he published his first scientific work on the "Basalts of the Rhine" (*Uber des Basalts aus Rhein*) in 1790, when he had scarcely passed his twenty-first year. He had already become known for his ardent desire of knowledge,

for his love of experiment and deep fervour in tracking a truth, so far as one can, to its fountain-head. Indeed, this, more than family influence, procured him his first employment, that of inspector of mines in the provinces of Bayreuth and Anspach. Holding this office, he was ever at work, and issued his second work, on the "Fossil Flora of Friberg" (*Flora subterranea Fribergensis, etc.*) He told us what shapes flowers had before the flood, how they bloomed and fructified; he gave us their forms, and the thickness of their fibre, and, by induction, showed us what soil they loved, and what brilliant colours they gladdened the young world with. Working still on, in a few more years he had advanced his studies from the dumb stone world, or fossil vegetable life, to that more wondrous organism around and about him, experimented on the nervous system of men and animals, and published his third work, "*Uber die Gereizte Nerveuse et Musculaire.*" The world began now to talk of this young *savant*, this devourer of books, this perpetual worker and thinker, who seemed determined to master the whole circle of knowledge.

DEATH OF HIS MOTHER—THE PROJECT OF LIFE.

It was late in the year 1796 that Humboldt lost his mother, his best and truest friend. To her he had always submitted, by her, famous and great as comparatively he was, he had ever been controlled. Her life alone bound him to the Old World, for he had long desired to experimentalize in the New. Freed by death from this dear tie, he eagerly flew to Paris, bought all the scientific instruments which he felt he should need, disposed of his estates in Prussia, and obtained permission from the French to join the Baudin scientific expedition then fitting out to survey South America. But the French Government were not quick enough for his hunger for knowledge. The expedition being deferred from time to time, he determined to wait no longer, and, in company with a young *savant* named Bonpland, Humooldt set out for Spain.

The grandees of that country were by no means uncourteous to the two young *savants*. Might not these two mineralogists discover a new Potosi? or, better still, a gold mine? or, indeed, it may be a diamond mine? Kings of Spain and other great folks are fond of diamonds and gold, and material wealth; so they would put forth their hand to welcome the young philosophers. His Majesty of Spain was pleased that young Humboldt should scientifically overrun his American possessions; so be it, he is everywhere well received.

BUONAPARTE'S EXPEDITION AND HUMBOLDT'S EXPEDITION.

In the meantime, whilst the preliminaries are being settled, the two philosophers meet with an English nobleman, a *savant* too, not too often met amongst our peerage at that time. This was Lord Bristol, and at his behest, and with his aid, Bonpland and Humboldt, leaving things to be arranged for them in Spain, prepared to run over and explore the wonders of Lower Egypt—a field for any one, and a field of wonders too. This was denied him however. Buonaparte, hated by Englishmen, was preparing his, by no means scientific, expedition to Egypt. Napoleon hated idéologues; what could scientific men want in Lower Egypt? The sword questioned the right of the pen, brute force was in the ascendant; Lord Bristol was arrested at Milan, and Napoleon went to Egypt; whilst the *savant* stayed at home, or rather in Spain, during the year 1788-89.

In May, 1799, however, Humboldt managed, in the Spanish frigate "Pizarro," to avoid the English who were blockading the Spanish ports, but whose ships a storm had

scattered, and to set sail for South America. He touched at Teneriffe, and ascended the celebrated peak. Hereby he established the Plutonian theory of the earth's formation in contradistinction to the Neptunian.

AMERICA AT LAST.

An epidemic, which broke out on board the "Pizarro," forced the captain to land his passengers at Cumana, on the north-east coast of Venezuela, and here all Humboldt's longings and aspirations were satisfied. He employed eighteen months in collecting specimens and exploring the country, and in a frail canoe ran up the Orinoco, penetrated to its source, and found its junction with the Rio Negro and the Amazon. Here his soul drank in that which he had so long longed for, and his eyes were feasted on immeasurable space. Here, says he, "you find a plain, bare indeed of any tree, but covered with rare herbs. Not a hill, not a rock, rises like an islet in this boundless space, this sea of land. Only some fragments of vast heaps of alluvial soil surge up, thinly scattered in a space of two hundred square leagues, and appear slightly higher than the surrounding plain. * * * In the midst of this grand and wild Nature a diverse and savage people live, separated each from each by a strange diversity of tongue. Some, like the Ottomacs and the Taurodos, are wanderers, living on grubs, ants, gums, and earth; others are more cultivated, and possess intelligence and gentle manners. The vast space between the Cassiquaire and the Atababo is peopled not by men, but by tapirs and apes formed into societies. Figures and characters cut upon the rocks testify that formerly civilization had advanced here. In the interior of the steppes, the tiger and the crocodile make war upon the horse and the bull; upon its woody boundaries man perpetually seeks to slay man; some, aliens of Nature, drink the blood of their enemies; others, apparently without arms, are yet prepared for murder, and slay with the poisoned nail of their thumb; the weakest tribes, creeping along the sandy shore, efface with their hands the traces of their timid footsteps. Thus, in the most abject barbarism, as in the deceptive glitter of refined civilization, man ever creates for himself a life of misery. The traveller who overruns all space, no less than the historian who interrogates all ages, has ever before him the sad and changeless picture of human discord."

Sad, indeed, is the reflection; sad, but true. It is for the good, the tender, the truly brave, and the kind, to knit up this ravelled garment of life. Well might Humboldt, observing the littleness and vileness of man, turn again to the continent—to that vast expanse, "wherein you grow almost accustomed to regard men as something unimportant in the order of Nature." But Humboldt loved man equally with Nature, and for him treasured up knowledge, no less than for himself. Geology, ethnography, and geography were the especial objects of his many travels; to these were also added natural history. After returning to Cumana with his friend Bonpland, and their admirable collection, they again set out and reached Quito in January, 1802. Five months were devoted to Quito, and to the exploration of its mountain valleys and the chain of snow-capped mountains which surround it. He ascended, on the 23rd of June, 1802, Chimborazo, the summit of which is 21,420 feet above the sea.*

In his "Cosmos," Humboldt has beautifully described the glorious sensation of looking out from the high mountain over the plains beneath him, and then told us that, to his latest day, the impressions he then had

* There is a school rhyme about this:—

"Chimborazo was formerly thought to be
The highest mountain which ever man did see."

We need scarcely remind our readers that the Eastern Hemisphere boasts the highest mountain, the Everest, a peak of the Himalayas.

will never be effaced. He was right; many years afterwards he would sit in the evening of the day, meditating upon the grand plains of South America, upon the golden prairies and mountain-heights of lands he had visited half a century before—of scenes as far removed in space as they were in time.

THE PURSUIT OF SCIENCE.

Humboldt's courage in the pursuit of science was immense. With Aimé Bonpland and a guide he passed whole nights in those frozen mountain peaks, where a false step might have been destruction, and where the very elements were at war with him. He ascended to so great a height that the rarefied atmosphere so affected him, that the blood gushed out from his nose and eyes; but even then the ardent traveller did not turn back, he went on until his senses reeled and he had reached the highest summit.

But it was now time for him to rest from his labours. The soldier of science had returned laden with spoils. It was necessary to arrange and classify those spoils, and Humboldt and Bonpland determined to return to Europe. This they did, previously visiting the United States, and being received with much acclamation by the people, and great friendship by Jefferson, who was then President. In 1804, they set foot in Bordeaux, after an absence of five years from Europe.

THE RESULT OF TRAVEL—HUMBOLDT'S WORKS.

The result of this voyage forms the monument—the greatest, most complete, and lasting monument to Humboldt and his companion. It was published throughout a series of years, but it is too vast and too expensive a work for any but the wealthy *savant*, or the public library. The mere titles of the books will show the reader what the labour must have been to obtain such a result:—

1st.—"Travels in the Equinoctial Regions of the New World." Paris, 1807—25, 3 vols. in 8vo.

2nd.—"View of the Cordilleras and the Indigenous Tribes of America, with their Habits, Manners, etc." 1810. In folio, with sixty-nine plates.

3rd.—"Zoological and Anatomical Observations on South America." 2 vols. 1805—32.

4th.—"A Political Essay on the Kingdom of New Spain." Under this title he gives his views of the policy, agriculture, mineral wealth, social and monetary economy, civil and military transactions of this kingdom. With an Atlas. Paris, 1811, 5 vols.

5th.—"Astronomical Observations, and Trigonometrical and Barometrical Measurements." 2 vols. in 4to. 1812.

6th.—"General and Physical Geography of South America." 1807.

7th.—"Essay on the Geography of Plants." 1805.

8th.—"A Political Essay on the Island of Cuba."

The very titles of these works will show the reader what an admirable, thorough, and continual worker was their author. The extremely short list we give of them could be driven out to a dozen times the length were we to particularize a thousandth part of the contents. Each of these works, though dependent on others, is complete in itself Maps, plans, charts, drawings of plants, rocks, ruins, insects, men, skeletons, trees, animals, minerals; in short, of almost every thing relating even distantly to science, are there to be found bearing the impress of the hand and mind of the great worker. Humboldt knew well that his work was that of a life-time. He devoted to it the finest years of his for nearly a quarter of a century, the work being issued in Paris during his sojourn there from the years 1804 to 1827.

It is in this sketch quite impossible to analyse these works. They are full of new

ideas and scientific induction. In one part he settles a question as to a South American tribe; in another he suggests and carries out completely his system of the Geography of Plants, and shows us how we may judge of the climate, the heat, the soil, and the general nature of a country by its indigenous vegetation. In a third he tells us the political history of a nation, and takes its social and economical measure. Little of importance is omitted. He is equally reliable on all points.

During his sojourn in Paris, Humboldt was the *savant* of the day. All learned men flocked to hear him and see him. He worked with some who are still foremost in the march of science. He wrote with Gay Lussac, Leopold de Buch, and Arago. He was sought for and honoured by kings and princes. He was elected member of the chief scientific societies of the world, and he was entrusted with more than one political mission. He had long been ennobled by the King of Prussia, whom he accompanied to Naples. Monarchs delighted to confer on him their orders of knighthood and of merit; but at the death of the philosopher, when heralds sought to chronicle these gewgaws, to give a fictitious brilliancy to the great man, all, save one modest star, which he often wore, were found neglected, tarnished, and covered with dust, in the drawer of that old bureau, at which he had so often sat, pen in hand, to chronicle his thoughts and his discoveries.

HAIN FRISWELL.

WATER-GLASS IN PHOTOGRAPHY.

—o—

Now that Dr. Johann Fuchs (formerly Professor of Mineralogy at the University of Munich) is dead, and therefore indifferent to praise or criticism, men are taking great interest in his inventions relating to water-glass, sometimes called soluble glass—inventions which promise yet to do good service in many a department of science, art, and manufactures. Fuchs died on the 5th of March, 1856, at the advanced age of eighty-two. A few months before his death, of which he is said to have had a presentiment, he was induced to write a pamphlet describing the principles, and some of the applications of his discoveries, in order, as he nobly says, "to render the experience gained by myself and others available for further investigations." In a thoroughly unselfish spirit he disclosed every detail that could in any way assist future workers. For a translation of this pamphlet, this country is lately indebted to H.R.H. the Prince Consort, who has chosen the journal of the society of which he is the patron (the Society of Arts) as the medium of its publication; the Rev. John Barlow, M.A., having previously, in 1854, given a popular exposition of the subject to the members of the Royal Institution, on one of their Friday evenings. The chemical principles of Fuchs' invention have also been for some years explained, and the results exhibited, at the lectures on chemistry delivered at our Government School of Mines and Museum of Geology, Jermyn Street, by its eminent Professor of Chemistry, Dr. Hofmann. Added to these sources of information, we have the report of an Imperial French commission, sent to Lille to examine the works of M. Kuhlmann, a distinguished follower of Fuchs, and to whom great credit is due for his ingenuity, enthusiastic perseverance, and success. This latter report is translated in the *Athenæum* journal.

We can here only attempt to open the subject for our readers, photographic and others, leaving them, should they feel incited to further inquiry, to pursue the matter under the authorities just named.

The story of Fuchs' life, in relation to his invention, is the old, old sad one of too many benefactors of our species—a story of disappointed early hopes, and a life of costly struggle against apathy, ignorance, prejudice,

and unjust self interest. If the theory of M. Flourens be true, that a hundred years is the true normal standard of man's life, then assuredly Fuchs may have lost twelve of his, by the adverse influence of disappointment and vexation, which even the bravest admit is felt on the failure of their legitimate hopes. Fuchs, in early life, had little attention paid to his really valuable discoveries. The world was then too ignorant and scoffing to pay attention to a man whose processes were founded upon elaborate, yet unassailable chemical reasoning. *Its* scientific faith was in *inverse* proportion to its ignorance. Let us take care that a future generation may not have to say the same of us. At the very period at which Fuchs was vainly asking attention to his views respecting water-glass, one Nicephore Niepce, of Chalons, on the Saone, was here in England ready to unfold his remarkable opinions in relation to light, and to dispose of his marvellous processes of photographic drawing and engraving—processes by which Daguerre was completely anticipated; but no one heeded him, and he returned to France a disappointed man, as we have lately learnt. Fuchs did not care to conceal his disappointment, for he commences his memoir with these words:—"In 1825 I had an opportunity of publishing a paper on water-glass, which at that time however did not meet with the attention which the subject well deserved. It was even stated that it differed in no respect from the well known 'liquor silicum' [water of flints], and, consequently, was *nothing new*. Experiments were made, but abandoned as soon as they did not lead to satisfactory results; undertaken as they were without the necessary knowledge or understanding. Greater expectations were raised than could in the nature of things be satisfied; failures, owing perhaps to faulty manipulation, frequently caused the process to be abandoned before it had been put to a fair test." How complete a picture is this of the trials and obstacles that have to be borne and surmounted by men who are philosophically in advance of their time, or who have to cast their suggestions amongst uncultivated, prejudiced, or selfishly interested minds! May we hope that the recital of such instances as these will make the present generation pursue more lovingly a wiser and more considerate course—a course upon which, it is to be hoped, we are now penitently inclined to enter. Worthy Fuchs was obliged to chronicle, that "There are always persons to be found who, themselves unable to carry on experiments, are always ready to condemn those of others, upon the faith of a *single experiment*, in which they failed; as," says he, "I have experienced myself, more than once." He adds, "An inert love of the customary and habitual almost invariably exerted the usual adverse influence." Shall we ever take warning by the past, and learn to estimate duly the "usual adverse influence" of many things, "customary and habitual," amongst us? But, to suppress nothing, the good old man, before his death, quaintly writes, "A few years have changed much, and it has been thought since that the water-glass, after all, did not belong to the class of superfluous things, and that *few other bodies were capable of being put to so many various applications*."

Let us now make a few brief notes of what these applications may be, and endeavour to get a rational idea of the chemical and physical principles upon which they depend. But, first of all, what is this water-glass, and how can it be procured?

The water-glass, or soluble glass of Fuchs, as it is designated in Gmelin's "Handbook of Chemistry," is, chemically speaking, a tetra-silicate of potash—a compound of silica, otherwise called silicic acid, and potash. The liquor silicum, already alluded to, is a mono-silicate. There is also a bi-silicate. Technically, Fuchs distinguishes four kinds of water-glass—potash water-glass, soda water-glass, double water-glass, and

fixing water-glass—each having its appropriate qualities and uses. Potash water-glass is made by fusing together, for five or six hours, at a high temperature, in a fire-proof pot, a mixture of

15 parts of pulverized quartz or pure quartz sand (otherwise silica, or silicic acid),
10 parts of well-purified potash,
1 part of powdered charcoal.

The charcoal is said to decompose any sulphuric acid left in the potash, and so a perfect vitrification of the mass is obtained. The hard, blistered, grayish black mass thus obtained is pulverized, then boiled with five times its weight of water, in which it slowly, but almost entirely, dissolves, in the course of a few hours. The solution is finally evaporated. With a larger proportion of silica, as pure rock-crystal, quartz, sand, or flint are termed, an insoluble glass, resembling ordinary glass, is the result.

Water-glass may also be obtained by Messrs. Ransome's method of dissolving broken flints in a solution of caustic alkali, at a temperature of 300° Fahr. Or an aqueous solution of potash may be saturated with freshly precipitated hydrate of silica, and evaporated. Or a fourth method may be employed, as indicated by Mr. Way, who dissolves a peculiar kind of sand, which he has described, at the ordinary boiling heat, in a solution of caustic alkali (potash or soda).

In order to obtain the mass prepared by either of these methods in the anhydrous state, it must be heated till it fuses, when all water is expelled. It is then a hard, transparent, rather infusible glass, which, on exposure to the air, absorbs so much water (without any external change, excepting that it becomes slightly fissured), that it swells up strongly when heated.

Its composition, when made with potash, is—

Potash	27·57
Silicic acid, four combining proportions	72·43
	100·00

An analysis, by Forchammer, established the theoretical statement of its constitution.

When fully charged with combined water it is termed hydrated water-glass. Simply drying the solution of water-glass yields this hydrate, which is colourless, transparent, and brittle, but softer than glass. It is slightly alkaline, and, after thorough drying, contains 26 per cent. of potash, 62 of silica, and 12 of water. The salt is permanent in the air; does not absorb carbonic acid from it; and effloresces only when accidentally mixed with other salts of potash. In the fire it swells up with loss of water, then fuses, and forms anhydrous soluble glass. Dilute acids decompose it, with separation of silica. It dissolves but slowly in cold, but readily in boiling water. After evaporation, it becomes very tenacious, and may be drawn out in threads, like melted glass. It dries up to a varnish, when spread upon wood, paper, linen, etc., the combustibility of which it diminishes. Sal ammoniac precipitates silica immediately from its solution. Alcohol also precipitates the soluble glass from its aqueous solution, withdrawing, however, some of the potash, until, at last, on washing the precipitate, octo-silicate of potash alone remains. Phosphate of alumina, and carbonate, phosphate, or sulphate of lead, when rubbed up with a solution of soluble glass, yield a tenacious mass, which becomes as hard as stone in the air. Baryta, strontia, lime, alumina, and oxide of lead combine with the whole of the silica and a part of the potash, to form an insoluble compound. Nearly all the soluble salts of the earths and heavy metallic oxides produce a bulky precipitate. These details of its chemical behaviour will enable the experimental reader to carry on those further investigations, which Fuchs so earnestly desired to see accomplished. The writer of this notice has proved that positive and negative photographs withstand sufficiently the action of boiling caustic alkali.

Therefore, although the soluble glass is described as being corrosive, experiments should be carried out as to its applicability to the improvement or preservation in any way of photographs on glass, paper, or porcelain; the suggestion of which was one of the main objects in introducing this subject under its present heading.

Let us now, before considering some applications more foreign to our own subject—photography—see if we can get a closer philosophical insight into this strange and useful thing, soluble glass, or tetra-silicate of either potash or soda. Its essential basis is the *non-metallic* element, silicon—or silicium, as it has been called by some, from its supposed metallic nature. Berzelius described silicon to be a brown powder, and judging of it in this condition, he compared it with carbon and boron, two other non-metallic elementary bodies. However, as aluminium, the new white metal, the basis of alumina and of clay, turned out to be metallic, it might be that silicon, the basis of silica, would also have to be classed with the metals. The researches of the distinguished French chemist, M. Deville, on aluminium, have, however, led to the production of many-sided crystalline plates of silicon, translucent and nearly colourless, not having any of the ordinary metallic properties. We must now, therefore, view silicon as a non-metal, and group it with boron and carbon, to which it has several points of resemblance.

This silicon, obtained by the action of aluminium and heat on silicious materials, burns in oxygen gas to form a white powder, the oxide of silicon, or silica, or silicic acid, as it is variously termed. Pure rock-crystal, opal, beryl, chalcedony, hornstone, jasper, quartz, flint, sand, part of all clays, etc., consist of this silica or silicic acid; indeed, it is one of the most abundant things in nature, as may be at once observed from this description of it. It is in one state soluble in water, and is found in parts of plants, animals, and animalcules, and notably in the canes, grasses, and stalks of cereals. This silica, or pure flint, fuses under the oxyhydrogen blowpipe to a clear bead; when fused, it may be drawn out into long threads like glass; dropped in a state of fusion into water it solidifies to a transparent mass, free from flaws, and remarkably hard and tough, so that it sustains the blow of a hammer without breaking. It seems to harden, like steel, by sudden cooling. Silica can be evaporated from solution by steam. The Geyser tubes of Iceland owe their formation to the fact of the possible solubility and volatility of silica, joined to its peculiar power of losing this solubility under fresh circumstances. Silica is tasteless, inodorous, and, though chemically an acid, is without action on vegetable colours. It can, under certain conditions, combine with water to form a hydrated silicious jelly. The soluble form of silica, obtained by precipitation from a silicate, loses its solubility by simple evaporation at a boiling heat, or little more. The varied and remarkable properties of silica must undoubtedly lead to further applications in practical manufacturing hands. The water-glass is the main door by which a practical man may best enter.

The silicic acid, or silica, being understood to be an acid, we can now see at once that, like other acids, it may form "salts." Soap is a stearate of soda—stearic acid and soda. This salt is miscible with water, while the acid of the salt, the fat, is not. So, in the same way, silicic acid, in its insoluble form, is made miscible with water by means of an alkali—potash or soda. In both cases stronger agents can throw out the combined acids, and, as we shall see in the case of water-glass, with novel and highly useful results. Even bodies not acid, as sal ammoniac, etc., can throw down the silica under useful conditions. But the scientific details and marvels of silica are exhaustless, and the eager student must pursue

them further in Gmelin and the authors already named.

And now, in conclusion, to consider some of the applications of silica in the form of water-glass to the arts. First, as most interesting to us, it is proposed to make careful photographic experiments with varieties of water-glass, adding more or less silica, as may be deemed fit. Water-glass has been also proposed (and is undergoing fair trial), in order to protect building stones from decay. The expectation is that water-glass, applied as a wash, will have its silica deposited by atmospheric carbonic acid, in minute adherent particles, upon the surface of the stone, which will thus be shielded by a flinty substance from the acids which smoky rain brings down in large towns; and where carbonate of lime exists in the building stone, a further action is expected from the formation of an insoluble silicate of lime, another protective agent. The decaying surfaces in the cathedral of Notre Dame, in Paris, the new Houses of Parliament, at Westminster, and many other similar buildings have been thus treated. Then it has been proposed to mix soluble glass with mortars, to enable them to set under water, by virtue of the insoluble silicates, which would form under circumstances of contact between water-glass and the materials used. Another and very important (for the fine arts) application is in the *stereochrome system of painting*, invented by Fuchs, and worked out successfully by Kaulbach in Germany, and Kuhlmann at Lille. The principle is to prepare a surface of cement or stone or slate in a manner proper to receive *dry colours*, and then to fix these colours on the wall or surface by means of a varnish of the soluble glass, which is syringed on, and left to dry. In a short time the carbonic acid of the air and the earths in the surface throw down the silica, or flint, the alkali partly combining; or it effloresces out, and is easily washed off, the picture remaining adherent, and only removeable by mechanical disintegration. Experiments made in exposed places, as to weather, have proved to be perfectly successful. A crucial experiment was made at Berlin by suspending a stereöchrome painting for twelve months in the open air, under the principal chimney of the New Museum at Berlin. During that time it was exposed to sunshine, mist, snow, and rain, and nevertheless retained its full brilliancy of colour.

To allude again to photography, it may be observed that from the description given of the behaviour of water-glass in a concentrated form applied to paper—its acting as a cement, or glue—it will be advisable to try its powers in the preparation of paper previous to the formation of the photographic image. Its action when mixed with gelatine and tanning materials also seems worthy of study by the photographer. It should be applied in a dilute form to the finished photograph, as a concentrated solution is reported to dry pulverulent. Bodies that do not cement well together with water-glass alone, can be made to cement by the addition of other substances. The various affinities of water-glass are very curious and interesting, and deserve minute study. Water-glass has been used successfully in painting upon glass, and it is in this direction that we also hope for valuable results to the photographer. The true way is to let each one in his own department endeavour to apply water-glass and its silicious correlatives in the best way his ingenuity can devise. It is confessedly a new and unworked subject, on which nothing very definite ought at present to be pronounced; but surely enough is here offered to stimulate to further trials. Wood and textile fabrics are rendered less combustible by the application of water-glass, and we have been informed by Dr. Müller that a glass-maker in Germany varnished the wooden roof blocks of an entire village with water-glass, now thirty years ago, to render them less liable to accidental combustion. Theatrical dresses and properties have also been alleged to be suitable for

similar treatment. Kuhlmann successfully exposed some old paintings on wood, protected by water-glass, to intense heat and numerous washings. This treatment they resisted. On glass, artificial sulphate of baryta, applied by means of water-glass, imparts a milk-white film of peculiar beauty, and this resists washing with warm water. By the action of a strong heat, the silicious varnish is transformed into a fine white enamel. Here, again, photographers on glass have a clue to further results. Kuhlmann, moreover, finds that an unassailable ink is made by grinding carbon with the water-glass. In calico printing the silicate has been tried instead of albumen to impart fixity to the colours, which, if not alterable by an alkali, resisted soap and washing. In printing and dressing stuffs, the water-glass, with starch and lime, or baryta, might be used to replace gelatine and tannin sometimes employed. Tannate of gelatine or starch, with lime or baryta, and the silicious material, have also been used in painting in distemper.

The study of water-glass is full of interest, for by its aid the formation of minerals and natural petrifactions can be elucidated. In short, builders, engineers, manufacturers, artists, chemists, physicists, geologists, and naturalists in general, may all find their account in studying the capabilities of this ingenious water-glass of Fuchs, and its applications in the hands of Kaulbach, Kuhlmann, and others. Should it be thought desirable, we may return to the subject at a future day. We have here given only a hasty *resumé* of the vast mass of facts and conclusions contained in the authorities already named.

Fuchs himself promised further details as to the applications of water-glass, but death stayed his hand. We have already mentioned his presentiment of death when about writing his pamphlet. This was only to be soon too true, and, as Dr. Pettenkofer remarks, "he who never deceived others, and rarely himself, was not deceived in this presentiment." His last words are, "To the Giver of all good be thanks for all joys and sufferings experienced! May his blessing be upon the work!

"Omnia ad majorem Dei honorem et gloriam!

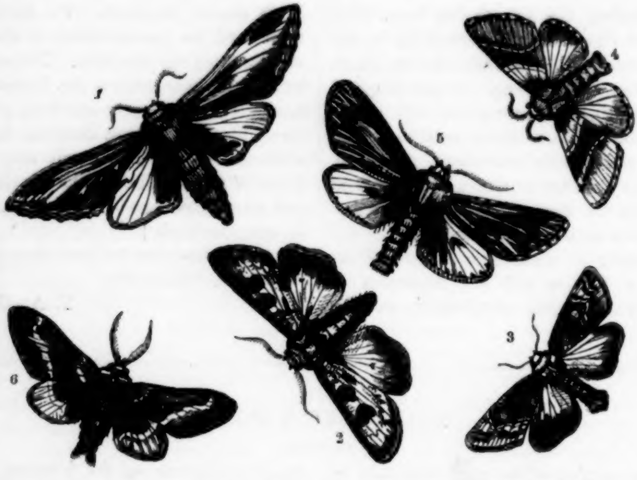
"*Munich, Nov.* 20, 1855."

T. A. Malone.

NIGHT-FLYING MOTHS.

A certain number of the moth tribe may be fitly separated as night-flyers, for the reason that several true moths fly by day, and are nearly as fond of the bright sunshine as the light-seeking butterflies, whose natural element it is. Those moths which only fly by night generally pass the day in a kind of torpor, from which some species cannot easily be awakened. In this state they may be found resting upon the trunk of a tree in a shady place, or on the underside of a leaf, and no amount of disturbance seems to rouse them from their trance. A pin may be stuck through the body, transfixing the dormant insect to the trunk of the tree on which it is resting, without stimulating it to exhibit any sign of awakening consciousness; and not till the time of flight arrives will it make any attempt to escape. It will then raise its wings leisurely, and try their strength as usual, without appearing at first to be aware that it is secured to the spot by an instrument passed through its body. The wings are at last put into the rapid motion used in the act of flying, and this action is continued with occasional cessation till the hour of flight is

passed, when the insect will relapse into the previous state of torpid repose. This is one of the proofs put forward by entomologists to show that insects are almost insensible to pain, and that the sensation of a moth in such a position as the one described is rather that of submitting to an inconvenience than of any acute sense of pain. The anatomical structure of insects is such, indeed, especially in the distribution of the nervous system, that any concentrated sense of pain, similar to that conducted to the brain by the nerves in the higher classes of animals, appears to be impossible to them. This will relieve the minds of many tender-hearted collectors, who might refrain forming a collection through fear of causing unnecessary suffering. Some of the most splendid of our native moths fly either very late in the dusk of the evening, or at different hours of the night; as, for instance, the Great Red Underwing, the still more beautiful Lilac Underwing, and many others; but these do not so often enter living rooms as some of the smaller and less conspicuous species, to which last kinds I would call the collector's attention, as they are well worthy of examination. Many of these, from being of nearly the same size, and generally of a brownish colour, are thought by the tyro to be all of the same kind. Every species is termed "a moth"—neither more nor less—a comprehensive term by which the unentomological world describe any of the tribe that happen to enter the open window late on a summer night, and flutter round the candle. The moth and the candle have, indeed, been associated in many a couplet and many a proverb, neither the poet nor the proverb-maker imagining that, even during the same evening, a dozen or more very distinct species may be observed, each approaching the light in his own peculiar fashion, and each having a peculiar flight, by which its species may be distinguished as characteristically as by the differences of the delicate markings, or the structure of the palpi and antennæ.



Linnæus, in his "Systema Naturæ," placed all the moths, with the exception of the *Sphingidæ*, in one grand group, which he called

Phalæna, a fanciful name derived from the Greek word φαλαινα, meaning an insect which flies towards a candle at night—a name evidently suggested to the great Swedish naturalist by the old proverbial image of the moth and the candle. The name is, however, no longer applied to the general group, to which, as a whole, it has been shown to be inappropriate.

Among those, however, which are strictly night-flyers a very pretty collection might be made; and some account of their habits, as observed by the student, and an accurate and careful description of their time of appearance, etc., might be made to form a very interesting record. The following are a few of the species which are attracted by a lighted candle. Supposing the window to be open, and a bright light burning upon the table, a succession of these scaly-winged visitors would, on a mild summer evening, in July or August for instance, continue to appear from dusk to dawn, each with its peculiar kind of flight; but only a few can be separately noticed. Among these, *Pheosia Dictæa*, popularly called the Swallow Prominent (No. 1), ought to be distinguished. This pretty genus of moths, of which there are two British species, are known as the "swallows," on account of the long lancet-shaped wings, and their remarkably rapid flight. The front pair of wings of this elegant insect are delicately marbled with shades of brown upon a white ground, the brown being blended in some places with a soft tone of gray. In its fitful flight, when agitated by the light of the candle, this insect continually darts towards the ground, and is lost in the darkness, soon to appear again glancing swiftly past the light, and then downward into the shade as before.

The caterpillar of this elegant moth is of a shining, reddish brown, with small white spiracular marks above the legs. It has the last segment conspicuously humped, as is usual with the caterpillars of this genus, and those of several allied genera, from which they are made to form a group, popularly known as the "Prominents." One species of a closely allied genus has two additional humps, or segments, nearer to the head, from which peculiarity the specific name "Dromedarius" has been conferred upon it. The caterpillar of *Pheosia Dictæa* feeds on the foliage of the poplar, birch, and other trees, and there are two distinct broods, the perfect insect appearing both in June and August. It is, however, by no means a common species, and if the young collector should find it come to his light on the first evenings of his experiments, he may consider it a prize.

Agrotis Corticea, the Heart and Club Moth (No. 2), is less fleet on the wing than the preceding, and instead of flying downwards, towards the floor, invariably flies towards the ceiling, attracted apparently by the mild white light by which it is pervaded. This moth, with its markings of plain brown, unvaried by any other tone, is yet well worthy of examination. The two brown marks in the centre of the front pair of wings, the upper one shaped like a heart, and the one next the body in the form of a club, are the most interesting, as having suggested the popular name of the insect; but the other bandings and scalloped transverse lines also form very intricate and delicate tracery. *Agrotis Corticea* belongs to a very numerous genus, composed of sixteen, or as some make it, twenty-three or more species, many of which are very common, as the Heart and Dart, and many others; but *Corticea*, the species described, is rather rare, and the caterpillar, as yet, remains unknown.

Cosmia Pyralina, the Lunar-spotted Pinion Moth (No. 3), if it enter a room, attracted by the light, is very wild and irregular in its flight, dashing from the candle to the ceiling, and from the ceiling to the floor. Its front wings are very richly shaded with full warm tones of brown; the light band towards the fringed edge, which widens and

forms a light patch at the front edge, being of a pale and dusky peach-blossom tone. It is a very pretty insect, but by no means common, though I have taken it more than once in a lighted room—always, I believe, on a rainy evening towards the end of July. The caterpillar of this pretty moth is pale green, with longitudinal stripes, of a paler tone, of the same colour, and a yellow line, edged with black above the legs. It feeds on the foliage of the plum, pear, and other fruit-trees, in April and May.

Clisiocampa Neustria, the Lackey Moth (No. 4), is as abundant as the last described species is rare; and yet it is seldom seen in the perfect form, as it is a swift night-flyer. Though the perfect moth is seldom noticed, unless sought by the entomological student, the caterpillars are known to every child, and, more especially to every gardener, by whom they are deemed pests of the worst description. Their bright longitudinal stripes of full blue-gray, pale silvery gray, orange, red, and black make them very conspicuous, and have been thought to resemble the lacings of rich liveries, from which circumstance both species has received the name of the "lackeys." The moth, on entering a room, attracted by a light, has the same wild flight as the species last described, and is rather difficult to capture, even with the aid of a proper net. This moth is of a delicate light buff colour, with a darker band, edged with lighter lines of the same tone.

Later in the season may be taken *Petasia Cassinea* (No. 5), popularly known as the Sprawler, which, like the last, is much more rare in the winged state than in the caterpillar stage of its existence. It is, however, often attracted by a light, when its flight becomes random, dashing heedlessly on all sides, through the flame of the candle, up to the ceiling or down to the floor. This species seldom appears before November, and is often found as late as December. It is late in the hour of its flight as well as in the season, often retarding its visit to the expectant candle, till one or two in the morning. The caterpillar generally feeds on the foliage of the privet; it is green, with yellow stripes, and, above a light line at the side, has a broad line of rich brown, shading off at the upper edge and blending with the green.

Still later appears the remarkably elegant little moth, *Pœcilocampa Populi*, the December Moth (No. 6), which, with its semi-transparent wings of deep purplish gray, with their pale buff transverse bands, will not fail to be considered a prize by the young collector. It is easily attracted by light, and, if any be in the neighbourhood, will make its appearance between the hours of seven and ten, on favourable evenings. The caterpillar of this pretty wintry visitant is pale ash-coloured, getting darker on the back, and having two pairs of red spots on each segment. It is found in June on the foliage of poplar-trees, becoming a chrysalis, when full fed, early in July, and remaining in that state till December, at which seemingly unseasonable time for so delicate a little creature, the moth emerges from the warm protection of its close horny chamber.

Great numbers of moths of more common species will come to the candle of the student, and many also of the larger and more conspicuous will doubtless reward a persevering nocturnal watch, even in a room; but a light in the open fields, or in a wood favourably situated, would yield a still more ample harvest; though it is not all the night-flying moths, nor even the greater number of them, that are attracted by a light; so that the fable of the moth and the candle does not hold good with regard to the whole moth family, and is, in fact, only applicable to a very small section of it.

H. Noel Humphreys.

—o—

SCIENCE ON THE SEA-SHORE.

I. FLINTS AND SPONGES.

—o—

WARM work on the shining sands, with the blazing sun in the meridian, and the surface of the broad and scarcely-ruffled sea covered with a throbbing vapour, that seems too oppressed to rise freely, and panting for a friendly breath of wind to help it in its journey upward. Not a cloud to give a momentary shadow and idea of coolness; and the heat seeming to come down in pulses to which every vein in the body beats time. Were it not for the faint gurgle of the sea breaking into sluggish lines of foam along the pebbled shore as the tide rises, we should believe we were consigned to an oven, to test the limits of human endurance. But the water is real—it sparkles as it breaks along the shingle, and its music is cool to the ear, and mentally subdues the fever of the body. But to turn one's eyes to the chalk, which right and left seems to be incandescent, is to risk blindness; it is too white to be gazed upon intently, and we must wait till the fervent sun sinks, hissing, into the wet horizon. There, after all, is a cool nook, and just in the very place in which we may trace the lines of flints as they lie in regular strata from the base to the summit.

What is flint? How it has puzzled the philosophers to answer the question, and how has the microscope assisted them! The most interesting point in the first step of the inquiry is, that flint always occurs in chalk, and usually in separate nodules, as flies occur in amber. There is one notable exception, in the continuous stratum which rises from the beach near St. Margaret's Bay, and there may be a few other examples; but the rule is, to find flints in beds, pretty regularly sprinkled over the surface, and every block having its own contour, distinctness, and individuality. Why should it occur in chalk? and if a deposit from water, why should it be in separate nodules?

Take a thin slice of flint, properly prepared for the microscope, and let the instrument unravel its history. If used to the detection of fossil infusoria, you will hardly fail to find them in it, and you gain one step towards an answer as to its history. Organized forms have had something to do with its formation; at some time very far back in the past there has been animal life there, and that life was marine. But you cannot account for the formation of separate and independent nodules of silica, scattered over a bed of chalk, by the help of these infusoria. Try a splinter of flint broken off in the rough; but be very careful not to spoil your object-glass by bringing the two surfaces into close contact. Now what do you see? Remains of shells, and here and there distinct traces of a sort of reticulated structure, sparry incrustations of a contour which you cannot but believe is derived from some organic form, long since annihilated. These appearances are repeated in various specimens, and have a general relationship one to the other, especially in the interlacing lines and spiculæ of which they consist. Now observe this specimen of *Pachymatisma Johnstonii*, which I have obtained on purpose for the comparison. Do you note the starry spiculæ with which its pores are beset, and which you see are flinty, and constitute the basis of the creature's skeleton? There is your index to the history of flints. The organic structure variously observable in the specimens owe their origin to sponges, in the structure of which silex is the main ingredient, just as carbonate of lime is the principal material in the bony skeletons of madrepores.

If we revert back in imagination to the period when these flints were formed, we see the floor of the ocean abundantly peopled with marine creatures. There were starfishes, echinites, madrepores, and infusoria;

but the sponges were, perhaps, the most numerous. Consisting of silica, with a very perishable organized tissue, these were ready at any time to undergo petrifaction, if circumstances were favourable. Bring two globules of mercury near to each other, and see how readily they run together into one mass. There you have a mechanical example of the way in which silica was precipitated from the water, and aggregated into nodules about the spiculæ of the sponges, and by degrees filled up the whole skeleton, preserving its form, but destroying its substance, and thus changing sponges into nodules of flint. Mr. Brande has imitated this very process in experiment, and has seen the formation of flinty nodules about a nucleus, when finely powdered silica has been mixed with other earths, and the whole diffused through water. Every separate sponge offering a separate nucleus, suffices to explain why flints should commonly appear, as they do, with such decided individuality of character; they are petrified sponges, formed in much the same way as those petrified forests travellers tell us of, where the trees are all flint; the woody fibre has disappeared, but the original structure is still traceable in the mass of silex in which the perished organisms are now represented. That silica abounded in the seas of the period in which the chalk beds were deposited is certain; but we are far from having arrived at a clear idea as to the chemistry of the whole subject to which flints introduce us. We can see the sponges in the flint, and the flint in the sponges, and the more we observe, reason, and compare, the more are we convinced of their geological and chemical relations.

Then comes the question, what is a sponge? Down here, in this wet hollow, we are sure to find some; in dark places, where the water is of some depth, almost every fragment of sea-weed has attached to it some living species of sponges, and they vary in size and structure, from mere specks to large and substantial masses. Now and then we may find them on the shells of oysters and crabs; and once, in our aquarium, a fine hermit came out of his shell to die, and was found to have a sponge as large as a hazel-nut attached to his soft body, just below the insertion of the last pair of legs.

Animal life may be said to begin or end in the sponges, they are the very lowest in the scale of animated nature; but it is quite certain they are not members of the vegetable kingdom. Take a piece of sponge, such as is commonly used on the toilet table, and dip it into a thin solution of size, and you have a fair resemblance of its condition when living. The sponge proper is the skeleton, the gelatinous coating is organized and animal; and the best proof of the fact is afforded by the microscope, which reveals ciliary motion, and there is an end of the difficulty as to what place it should occupy. The openings in the sponge are chambers, interlaced with silicated fibres, and, by the play of the cilia on the gelatinous surface, the water is made to circulate from chamber to chamber, so that the sponges obtain their food by the same process as a vorticella or rotifer—namely, by creating currents through the agency of cilia. The exterior film is the life of the sponge, the skeleton is a deposit. But the film must be understood as pervading the inner as well as the exterior chambers, so that the currents of water pass through the entire mass, and carry nourishment to all the mouths for which the cilia work so incessantly. A very dead sort of creature is a living sponge. It has none of the organs of sense which distinguish terrestrial animals, and not even the irritability which makes a sea-anemone of so peevish or spasmodic a temper. But it has its history, however brief, like others of the great class of zoophytes. The sponges increase by gemmation. Little buds appear within the openings of the reticulated mass, and these at last detach themselves, and

exhibit the same play of cilia as their parents.

But, instead of at once becoming fixed, the action of the cilia causes the sponge to spin about in the water, so as to have a real locomotive power of finding for itself a site, where it casts anchor, and for the rest of its days never knows either the pleasures or the pains of travel. If every separate flint was once a separate sponge, this locomotion accounts for their detachment and their subsequent concretion in distinct nodules.

In the tank fitted up by Mr. Bowerbank, and presented to the Crystal Palace, there were, not long since, a number of living sponges, in very good condition for observation. Whether they remain there we know not, but we can tell those who keep aquaria that, if the dredge or the hand-net bring up specimens which it is wished to preserve, that the great secret is darkness. In the light they soon perish and cause putrescence; in a very subdued daylight they live for a length of time, and may so be preserved for microscopic observation. There are not less than sixty species inhabiting the British coasts, and they differ considerably in their conformation, though corresponding in their physiological structure.

SHIRLEY HIBBERD.

THE KEY TO A BIRD'S HEART.

THE number of feathered songsters that annually find their way into cages in England alone, and are kept unhappy prisoners there, can hardly be credited. It may be fairly stated at very many thousands. Of these, multitudes die from neglect or starvation; and how many broken-hearted? The few that survive, with certain choice exceptions, drag on a miserable life of lingering captivity. Forming a part of the household furniture, they are kept until they are worn out; they are then replaced by others! There is "fashion" in bird-keeping as well as in everything else. The question is, Should these things be? I say, No. Birds have very, very tender little hearts; and they are quite willing to love us, if we will only let them. But we won't! Let us reform this altogether.

I shall take it as granted that every reader of *Recreative Science* is of a genial and kindly disposition. There will therefore be a cordial assent to the doctrine, that we should strive to make everything living beneath our roof "happy." How is this to be done? Nothing more easy. There needs but the will, to accomplish the object. This leads me to remark upon a very interesting fact, viz., that every human being is a magnet—powerful as any steel magnet can be, albeit formed of a softer material. The powers of attraction and repulsion are born with us; an observant eye may detect them in daily operation. Thus, no one person can touch another person without imparting and receiving some influence from the contact. Try this on a bird. Fondle it, and press it to your cheek: it will soon become sensible of your affection.* The eye, the hand, the breath, the will—all act on it. There are many of these sweet secret affinities running throughout Nature. Opportunity discovers them. The influence is excited by proximity; it is developed by contact. How very much of the enjoyment of life is lost from the want of a knowledge of this little secret! "Natural Magic" should be sedulously studied. It gives us irresistible power, over both man and animals; and thus enables us to live in *two* charming worlds at once.†

* During a recent professional visit to the north of England, and while in Liverpool more particularly, I quite astonished all the lovers of birds. Ere I took my departure, I had made many of them quite proficients in the Art of Bird-taming.

† Having had in my possession, at one and the same time, no fewer than 366 feathered songsters, and many other animals, I speak from experience—*all* were tamed by "Natural Magic."

But a question here naturally presents itself, Are *all* birds alike sensitive? Are they *all* open to these genial influences? Certainly not. I am sorry to say there are *many* instances in which the power I speak of is ineffectual—quite. Some birds, and other animals, like certain human beings, show no sympathy whatever. Nothing can please, nothing can win, nothing can attract them. We succeed best with them, when we take no notice of them! Strange, but true. This confirms my remark, that sympathy is the only *true* magnet. It must be born with us; or it does not exist. It is a part of ourselves:—

> "The tender violet loves to grow,
> Within the shade that roses throw;
> The myrtle bends towards the rose—
> Behold how GOD his wisdom shows
> How natures, *formed alike*, come nigh,
> Attracted by sweet sympathy!"

It were indeed vain to attempt to unite the two poles!

But now to our feathered favourites. Perhaps they have hitherto been treated with neglect, perhaps ill-fed, perhaps exposed to all sorts of weather—their too common fate. Poor little innocents! Restore them at once to favour, and redouble your attention to them. It is the least you can do to make amends for your past cruelty. Let them occupy a place in your drawing-room—why not on the table, in a noble, spacious dwelling? If they *are* your friends, don't be ashamed of them. Talk to them, sing to them, play to them. They love to hear the sound of your voice, and they can readily recognize your approaching footstep. A day or two will work wonders. You will soon be able to let your visitors see that your "pets" really *are* pets—realities, not counterfeits. To have a bird, or an animal of *any* kind, in our house, that does not "love" us—the idea is quite heathenish.

The next thing is, to show the power of "Natural Magic" at the breakfast-table. It is *here* you will find that you possess the key to your bird's heart. Invite him regularly as your guest, and bid him heartily welcome. "Dicky" must be—shall be—one of our "Happy Family." So place him on the table—every morning.

Now let us imagine—the morning sacrifice duly paid, and all comfortably seated around the well-spread table with smiling faces—that we are about to take our grand lesson in Bird-taming. Open the door, or doors, of your little friend's dwelling. Let him see he is invited to be "free." Have ready on the table-cloth some little delicacy in which he delights, such as a sprig of ripe groundsel or flowery chickweed, a wee morsel of egg, or a bit of sponge-cake—above all, his bath. His little majesty will note all that you are doing, and readily resolve in his active mind the meaning of all he beholds. If he has been long neglected and treated with indifference, it is just possible he may *not* realize on the first morning all you expect from him. He will, perhaps, alight on the edge of the open door, look out, survey all that is going forward, and return to his old quarters. The rest of the day he will devote to thinking matters over. That birds *do* think, I am quite prepared to "prove."

Next morning, again invite your pet or pets; again open their doors, again spread before them some tempting luxury. Mark the result; and let it be decisive evidence that birds have very retentive memories, as well as tenderly-affectionate hearts. Looking up archly, your little friends will leisurely descend from their seat, hop along the table, help themselves to some tid-bit, and stare you boldly—ay, saucily—in the face. They will then show their "consequence," by coquettishly approaching close to your tea-cup; and perhaps, with extended wing, give you battle. A week will accomplish all this—and more.

The game is now your own. Every morning will add to the tameness of your pets, and their droll audacity will afford you in-

finite amusement. Your conquest completed, you will find many a sweet little song improvised for you, and warbled *sotto voce* from the windows of their habitation. Mind and listen attentively to it. Approach lovingly, and bend your head forward. Then present one of your fingers. It will be gently pecked at. Next, your lip. *That* will be welcomed by a "chaste salute." The bird's affection cannot go beyond this. Such a mode of salutation seems to be the *only* natural way of expressing the deep feelings of an affectionate heart. It rules throughout all Nature. Let us honour it, and ever rate it at its real value. *Honi soit qui mal y pense!*

One word more. When you have won your bird's heart, mind and keep possession of it. The heart of a confiding little bird must not be trifled with. It is not like the human heart—pliable and elastic as India-rubber. No; while one bends, the other breaks. We mortals have the oddest possible ideas about "love." We can love one, twenty, *or* fifty! Little birds want only "one" love. In this they live; in this they die—happy. Surely, if only for variety's sake, it is well to possess—The Key to a Bird's Heart (?).

William Kidd.

THE GYROSCOPE.

"What is a gyroscope?" is a question that many persons have asked, and many more have found some difficulty in answering. To furnish a reply to those who have made the inquiry, and to excite the attention of those to whom the remarkable phenomena exhibited by the gyroscope are unknown, is the object of this paper.

The instrument in question is the invention of a French philosopher, M. Foucault, to whom we are indebted for the celebrated demonstration of *the earth's axial rotation*, by means of a pendulum. It consists of a wheel, carefully attached to an axis, having the mass of metal composing it disposed around its edge, in order that, when it is put into rapid rotation, it may revolve for a longer time than it otherwise would. The axis of this wheel is hung within a ring, which latter is suspended to the end of a semicircular arm, and this, by means of a spindle attached to the middle of its outer edge, is placed on the top of a pillar, rising out of the foot that supports the entire instrument.

The apparatus may, therefore, be described as consisting of a heavy foot, A, from which rises a hollow pillar, B, supporting, by means of the spindle before alluded to, the semicircular arm, C, with its two ends upwards, the spindle being a *vertical* axis, on which this arm can rotate. The ring, D, is attached to the end of this arm by two pivots, which form a horizontal axis, on which the ring can move; and through the edge of the ring, at right angles to the pivots by which it is suspended, two screws, E, F, are inserted, and these support the axis of the wheel, G. These arrangements enable the wheel, by means of a cord wound round its axis and quickly drawn off, to have communicated to it a rapid rotatory motion, the plane of such motion being capable of variation, from the vertical to the horizontal, or any intermediate position, by moving the ring on the pivots which form its axis; while the spindle attached to the semicircular arm, enables the entire system of wheel, ring, and arm to rotate horizontally.

The following, among other experiments, can be performed with the gyroscope, illustrating the following principles:—

That inertia is a property of matter in motion, as well as of matter at rest.

That the power possessed by Armstrong's and similarly formed guns, of resisting the influence of gravity, is due to the gyratory motion given to the ball as it leaves the muzzle of the gun.

That *orbital* and *axial* motion are intimately related, and that the speed of one may regulate that of the other.

That the condition of unstable equilibrium in which many bodies remain, is to be explained by the fact of their rotation; as, for example, a child's top, etc., etc.

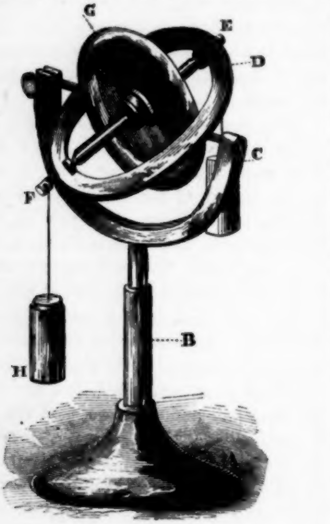


Fig. 1.

Examine the instrument while in a state of rest, and it will be readily moved in any direction, the slightest touch being sufficient to alter the position of any of its parts; and if the stand be slowly moved round on the table, the entire system of wheel, ring, and arm will be moved round with it.

Rotate the wheel by the aid of the string, as before described, and a remarkable change will be manifest. The wheel will now offer a great resistance to any attempt to alter the plane in which it is rotating, and the other parts of the instrument, like it, seem to partake of a similar indisposition to be interfered with. The stand may now be moved round on the table, but the wheel will not move with it; the wheel and ring remaining apparently immoveably fixed. If the instrument be held in one hand by the stand, the same takes place, whatever be the direction in which it is moved. If the ring be removed from the arm, while the wheel is rotating, and held in the hand, the sensation experienced is like that which would be felt if it were a living thing struggling earnestly to escape.

When the wheel is at rest, hang one of the cylindrical weights, H, on either of the heads of the screws, E, F, that support the axis of the wheel, and, as might be expected, that side will, by the operation of the law of gravity, be immediately pulled down. Remove the weight, restore the wheel to its vertical position and rotate it, and hang the weight on again. The wheel now resists the influence of the weight, and maintains the position it was in before the weight was applied, the rotation of the wheel apparently neutralizing the law of gravity.

Not only will the wheel retain its position in spite of the influence of the earth's gravity, represented by the weight, but the entire system will commence a rotation on the vertical spindle attached to the semicircular arm. This last rotation is due to the action of the weight, for if this be lifted off the movement instantly ceases, and commences as soon as the weight is hung on again. If the weight be hung on to the opposite end of the axis of the wheel, the rotation of the system on the vertical spindle still takes place, but in the opposite direction.

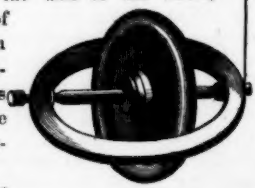


Fig. 2.

Rotate the wheel, and then remove it and the ring from the arm, and hang them on to the end of a string by one

of the screws on which the weight was suspended (Fig. 2). Instead of falling, as might have been expected, the entire mass preserves the plane in which it is placed, although the whole weight of the wheel and ring is on one side of the point of suspension, and a revolution of the whole is commenced round this point.

These secondary revolutions seem to be due to the law of composition of forces, for the wheel is acted upon at the same moment by the gravity of the earth, and also by the peculiar property of resisting attempts to change the plane of its motion consequent upon the state of rapid rotation in which it has been put.

The peculiar forces exhibited by the gyroscope may be due to the property of inertia which belongs to all matter, and by virtue of which it cannot move itself when at rest, or stop itself when in motion, or when in motion change the plane in which it is proceeding.

Or they may be traced to the direct influence of the force communicated to the wheel, all the particles of which, while rotating, have a tendency to fly off in a direction tangential to the circle in which it is moving, and in the same plane in which the rotation is taking place. Any attempt, therefore, to interfere with the direction of this plane will have to contend with the force with which, were they not restrained by the law of cohesion, every particle composing the wheel would fly off.

E. G. Wood.

Grand Prize Bird Show at Southampton.—We hear of a variety of provincial "bird-shows" in preparation, and among them an important one at Southampton, open to all Hampshire. It is announced as being under the highest patronage, and we hope it will fully realize the sanguine expectations of its projectors. It will take place late in the autumn, and be under the superintendence of Mr. Wm. Kidd, of Hammersmith, who is to give one of his popular "Gossipping" Entertainments on Song Birds each day of the exhibition.

ASTRONOMICAL OBSERVATIONS FOR AUGUST, 1859.

A total eclipse of the moon will occur on the 13th of August, but will be invisible in England. It will be visible in latitudes 14° and 15° S., and in longitudes 67½° to 158° E. A partial eclipse of the sun will take place on August 27th, which will also be invisible in England. It will begin at 15h. 30m. G.M.T., in latitude 28° 3′ S., and longitude 42° 57′ E., and end at 18h. 31m. in latitude 77° 23′ S., and longitude 121° 34′ E. The greatest eclipse will occur in latitude 61° 40′ S., and longitude 33° 51′ E., at 17h. 1m., G.M.T., when above half of the sun's limb will be obscured.

Full moon on 13th, at 4h. 34m. p.m.

New moon on 28th, at 5h. 14m. a.m.

The moon is at her least distance from the earth on 27th, and at the greatest on the 12th.

The sun is in the constellation Leo until the 23rd, and then in Virgo.

Mercury is in Leo throughout the moon, and is favourably situated for observation at the commencement of August. It is in conjunction with the moon on the 28th.

Venus is small, and nearly circular. On the morning of 21st she will be within 10′ distance of Saturn, and at midnight of the same day within 4′ of Mars, the three planets forming a cluster.

Mars is invisible near the sun, and at its greatest distance from the earth on August 1st.

Jupiter is in Gemini, and is a morning star.

Saturn is near the sun, and invisible.

August is remarkable for the great number of meteors, which more especially take place about the 9th and 10th.

On the 1st the sun rises in London at 4h. 24m. a.m., and sets at 7h. 47m. p.m. On the 31st he rises at 5h. 11m., and sets at 6h. 48m. p.m.

On the 1st twilight ends at 10h. 40m. p.m., and day breaks at 1h. 32m. a.m. On the 23rd twilight ends at 9h. 21m. p.m. On the 7th, length of day 15 hours.

Occultation of Stars by the Moon:—On the 13th in Capricorni, 5th magnitude, disappearance, 11h. 50m.; reappearance, 12h. 12m. meantime. On 14th, No. 67, Aquarii, 6th magnitude, disappearance, 16h. 40m.; reappearance, 17h. 41m. On 18th, No. 101, Piscium, 6th magnitude, disappearance, 13h. 31m.; reappearance, 14h. 25m. meantime. E. J. Lowe.

Highfield Observatory, Nottingham.

Occultation of Saturn by the Moon, May 8, as observed at Cambridge Observatory, occurred earlier than was expected. Professor Challis remarked that the moon's limb, where it crossed the middle of Saturn and his rings, appeared to be unusually curved, and that both the ball and the ring were reduced before disappearance to a very narrow strip of light, and also that a lingering in disappearance took place. The colour of the planet was in remarkable contrast with the whiteness of the moon's light.

THINGS OF THE SEASON—AUGUST.

FOR VARIOUS LOCALITIES OF BRITAIN.

The following are intended merely as reminders for out-door naturalists and collectors :—

Birds Arriving.—Mountain Finch, Siskin, Blue and Gray Gull, Crossbeak, Gray Plover, Purple Sandpiper, Cambridge Godwit, Knot.

Birds Departing.—Lapwing, Field Titlark, Dottrell, Razor-bill, Turtle Dove, Quail, Cuckoo, Swift, Wryneck, Puffin, Foolish Guillemot.

Insects to be Sought.—Field Cricket, Clouded Sulphur Butterfly, Camberwell Beauty, Callistus lunatus, Red Admiral, Brown Hair-streak, Purple-edged Copper, Middle Copper, Pear Skipper, Brown-tailed Moth, Yellow-legged Locust, Painted Lady.

Wild Plants in Flower.—Purple Melic Grass, Small Teasel, Devil's Bit Scabious, Corn Bell-flower, Hoary Mullein, Dodder, Marsh Gentian, Alpine and Water Parsnep, Water Hemlock, Samphire, Fiddle-dock, Small Water Plantain, Common Soapwort, Orpine, Horsemint, Wild Basil, Daisy-leaved Cardamine, Small Fumitory, Dwarf Furze, Yellow Vetch, Hawkweeds, Plume Thistle, Southernwood, Fleabane, Chamomile, Yarrow, Ladies' Tresses, Sea Spurge, Wild Amaranth, Club Moss.

METEOROLOGY OF AUGUST,

FROM OBSERVATIONS MADE AT THE HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1842	85.5	44.0	—
1843	85.5	45.0	—
1844	80.0	40.0	2.3
1845	74.5	44.2	4.8
1846	86.0	50.0	3.3
1847	76.5	38.0	1.4
1848	74.7	37.2	4.8
1849	80.8	38.8	1.7
1850	79.0	34.2	1.0
1851	84.5	36.0	2.1
1852	81.5	46.5	3.3
1853	77.3	38.0	4.3
1854	81.5	40.8	1.4
1855	81.2	40.7	1.1
1856	92.5	40.5	4.0
1857	85.8	46.0	6.2
1858	83.0	39.8	2.8

The greatest heat in shade reached 92.5° in 1856, and only 74.5° in 1845, giving a range in greatest heat of 18.6° during the past seventeen years.

The greatest cold was as low as 34.2° in 1850, and never below 50.0° in 1846, giving a range of 15.8 in greatest cold.

There has never been less than an inch of rain fallen in August, whilst there was as much as 6.2 in. in 1857.

August is subject to great weather changes, and in the first fortnight severe thunder-storms usually occur, more especially about the 9th of the month.

E. J. Lowe.

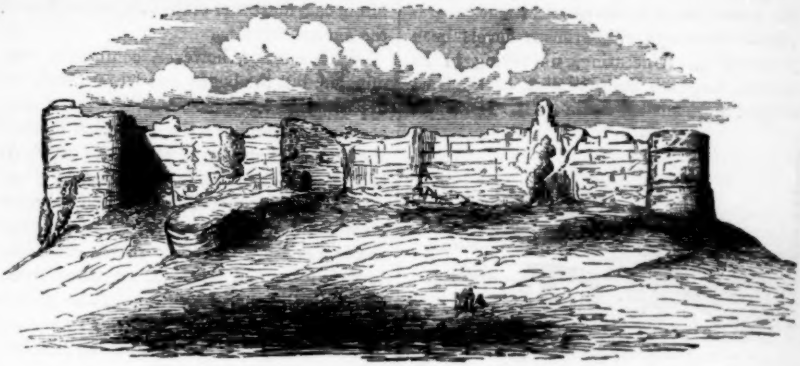
Mr. Noteworthy's Corner.

How to Observe the Habits of Birds.—Mr. Noteworthy has a favourite nook in his garden very much enshrouded with overhanging branches, where the birds love to congregate and warble sweetly. Every year a large patch of hemp is sown to make a graceful tuft of green, and as soon as it begins to ripen seeds, the tomtits crowd the stems, and in all sorts of comical attitudes enjoy a daily feast. This year the feathered family is more numerous than it has ever been, and very lovingly do they chatter to their delighted benefactor. The birds on the branches are not too far off for a minute inspection of their plumage when a short focus telescope is used in the observation. Mr. Noteworthy once suggested to a London optician the advisability of producing a telescope expressly for naturalists. The hint was not taken; it is now offered to the world : Wanted, a Naturalist's Telescope, adapted as to focus for the observation of birds at from five to twenty yards' distance. Cheap enough to command young people's pocket-money, and good enough for the vision of a philosopher.

Miniature Rockwork.—The best of all materials for rockwork in fern-cases and aquaria, except where only a few loose blocks of stone are required, is common coke. Break the coke into pieces of a suitable size for the intended structure. Make a thin batter of Portland cement, and dip each piece into it. Repeat the dipping after the first has set, and then build up and cement together with Portland. Masses of rockwork are objectionable in aquaria and fern-cases, from their enormous weight, but by employing coke, you have it almost "as light as a feather." To make a pyramid, take a flower-pot and cement fragments of broken burrs all over it. It may then be lifted in or out of a tank or fern-case with the greatest ease, and is far preferable to a permanent structure.

Flints in the Drift.—The recent discovery of flint implements (?) in the drift, has given rise to considerable discussion as to whether they are to be regarded as *bona fide* products of human art, or, as Mr. Wright has it in his correspondence with the *Athenæum*, "the result of some mysterious operation of Nature." Mr. Noteworthy has at present no opinion on the subject. He has seen some of the so-called implements, and, instead of jumping to conclusions, will see them again and again, and in the meantime revolve the matter in his mind. Those who are in the habit of visiting the library of the Society of Antiquaries should not fail to obtain a view of the objects, on the presumed history of which, doubtless, many very pretty hypotheses will be put forth.

New Solvent and Cement.—Copper dissolved in ammonia is, by the *Builder*, said to form a solvent which acts on woody fibre, wool, and silk in such a way as to produce a waterproof cement; and cotton fabrics saturated with the solution of wool take dyes which have hitherto been used only to woollen goods. Many useful appliances are anticipated from this discovery.



PEVENSEY CASTLE.

THE CEASELESS WORK OF THE SEA.

ROCK-STRATA AND THEIR MATERIALS.

NEAR where the Norman Conqueror first set foot on English soil, stands an old and stately ruin that,

> "Lifting its forehead gray,
> Smiles at the tempest and Time's sweeping sway."

Roman tiles, peering with ruddy faces through the "ivy green" mantling the stately walls, point to its first founders and to its ancient prime and glory; while the great masses of neatly-trimmed and close-fitting squares of Caen stone show the extensive additions made by the martial men of a later age, who possessed and renovated the fortress.

Before those lichen-covered walls the red-haired Norman king encamped, when within their protecting range the ambitious Odo sought refuge. Stephen, too, sat down before them; and from those grass-grown parapets and bastions, the bright eyes of the lovely maids of Provence, whom Peter of Savoy brought over to wed to English lords, looked out, six hundred years ago upon a damp and oozy tract around.

Through those gapped and crumbling walls the "bleak winds wafted from the main" now sigh and moan, and rushing on, press down the tall, rank grass on the numerous hummocks that dot the surface of the marshy plain. These, when the brazen helmets of the Roman sentinels glittered on those solid buttress-towers, were little islets in a great and shallow bay; and the river, which now travels through a long and artificial channel to the sea, flowed down close by the castrum-walls, and formed a Roman naval port.

While thus the waters of the daily tides flowed and ebbed around the hummock-isles, a solid buttress of the Roman fortress, undermined, fell out, and tumbled sidelong on the muddy slope. So the Normans found it, and when they mended up the cracks in the old masonry and extended the works, they built up, erect and strong, a sallyport over the prostrate mass.

Gradually, slowly but surely, and certainly, from the time when Roman hands surrounded the island-hummock with its

stout, broad wall unto this very hour, has the great change in the physical and geographical characters of Pevensey levels been progressing. Unceasing, unvarying in its process, has been the alteration of the tract around those ancient castle-walls. The winds

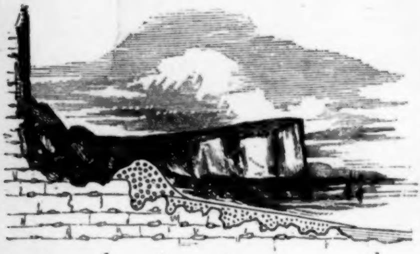


FIG. 1.—Diagrammatical Section of a Chalk-cliff, showing the waste of land and the sorting of the materials by the sea. *a*, Fallen masses of chalk-rock; *b*, flints left on the shore by the washing away of the soft chalk, and forming a *beach* along the level of high tide; *c*, finer fragments, or *sand*, deposited in the tidal zone, between high and low water; *d*, very fine earthy particles, or *mud*, deposited under water.

driving along the shore, by means of the boisterous waves, the flint-shingle, derived from the abrasion of the cliffs of Beachy Head, first formed a tongue-like bar, the point of which, ever creeping onward with the accumulation of each succeeding tide, gradually shut in the estuary, which then, by means of the river continuously bringing down fine particles of mud, powdered by the rain and weather, from the surrounding hills and lands, in the lapse of time has been completely silted up. Thus has been changed the whole face of the district, and sheep and cattle graze on verdant pastures that have supplanted the brackish waters of the indented bay. In the mud, sand, and gravel strewn over this great plain, river-shells, bones of wolves and other beasts, of porpoises and fish, cockle and oyster-shells, ancient canoes, and bones of domesticated animals remain embedded, with the leaves and stems of hazel, birch, oak, and other of the indigenous trees of the ancient forests.

Such are not, however, confusedly commingled, but the bones and larger *debris* are deposited in one place, the shells and finer sediment in another; the calcareous shells of the lymnæans are found still in the old river-course, the oyster-beds at the former river-mouths—all have been buried upon the spots on which they lived or grew. The bones and the canoes are where the currents, according to their force and strength, deposited them, affording thus clear evidence of the succession of the prominent events which have occurred during the progress of the natural operations instrumental in filling up the ancient bay.

Just as the history of the old castle itself has to be made out from the study of its masonry and its varied styles of architecture —just as we have to test the knowledge derived from the correlative sources of history, old deeds, legendary tales, and traditions, by the indicative characters of its actual structure; so, in the study of the past history of the physical conditions of any portion, however limited, of the dry land of our globe, we have to measure all the other corroborative or extraneous evidences by the standard of the conditions of the strata, or beds of mineral matter themselves. As the marks of the mason's chisel or the trowel are in archæological inquiries valuable indications of the national workman by whose hands they were made, so, too, the position of a shell in the consolidated silt, the fragmentary or perfect condition of a bone, and many other apparently trifling features, have significations and values of high importance in geological or physical investigations.

And the rock-strata of the earth are the consolidated muds, sands, and beaches of other shores and other ages—their fossils the petrified remains of the shell-fish, plants, or beasts, that existed on them or the adjacent

-ands. Every relic bears its own record, the faithful interpretation of which is ever to be got by careful and intelligent study.

Now that we have completed our historical survey of the expanded levels of the Sussex shores, let us extend our view still further backward in time, and inquire how that ancient bay was formed. The surrounding land, then, was first excavated by water, even as since the space thus cleared out has been refilled and reconverted into dry land by the same agency. Long before Roman or Norman trod on British soil—long before the aboriginal Celt, unknown to us save by the rude flint axe or arrow-head, or by a few bleached bones reverently laid in simple cist of unhewn stones, or hollowed log of wood—long before the first-born of the human race began his mundane course of pain and pleasure—long indeed before, far back in the abyss of time, there have been such changes of land and sea, such out-cuttings and in-fillings, such wearing down of higher lands, such levellings of ocean-spoils, both on great extents and smaller scales. In the oldest rocks—myriads of ages old—the constituent particles of quartz or mica, no matter how finely ground, tell of the still older wasted gneissic lands from which those particles were thus derived; the embedded fossils, so unlike the life-forms of this present age, confirm in their quaintness the testimony of the rocks; the rippling sea left ruffles on the sand; the rain-drops of sudden showers pitted its smooth and glistening surface; worms drilled into it, and shell-fish burrowed in the ooze; green, limp sea-weeds gently floated in the tidal pools; and sometimes the sea in its gentlest mood spread a gauzy film over the beautiful scene, and carefully preserved it for ever.

Still the sea was at its ceaseless toil, ever destroying and ever renovating—restlessly, ceaselessly biting into the land and heaping up its spoils upon its shores.

In the smooth, rounded spurs jutting from the surrounding higher and more ancient ground into the Pevensey flats—in the rounded contour of the bounding hills, the bold, steep escarpment of the chalk downs, we see as plainly the denuding action of the ever-toiling sea. If we stripped off their velvety sward from those far older soils, we should find, if we dug downwards below the subsoil, some great mass of mineral matter, such as clay, chalk, limestone, or sandstone.

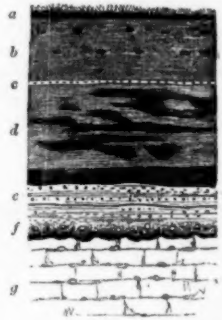


FIG. 2.—Section exposed in a brick-pit near Windsor, showing the differences of mineral composition, and the succession of rock-strata. *a*, Vegetable soil; *b*, London clay; *c*, basement bed of London clay; *d*, *e*, mottled clay and fire-brick earth; *f*, bed of green-coated flints in dark sand; *g*, chalk.

If we dug very deep, we should find that such masses alternated with, or reposed upon, each other. We should find, too, that these *rocks*—for by that term geologists designate the great earth-masses forming the crust of our globe—contained peculiar fossils, or petrified organic remains, different forms of which were characteristic and distinctive of each separate mineral stratum. If the strata or beds of earth had any particular inclination, we should obtain all this knowledge without digging, by simply walking over the country and noticing what happened at their *outcrops*, as those areas are termed where the beds rise and present their *bassetting* edges at the surface. If we thus extended

our walk beyond the immediate region of Pevensey, we should see, in the railway-cuttings, the roadsides, and in the banks of rivulets, that these sands, clays, and stones succeed each other in regular and definite order; that one after the other they lead up to the chalk-hills, under which they *dip* downwards and disappear. Some of these strata contain ammonites, or great ornamental nautilus-like shells, sponges, palatal teeth and scales of fishes, molluscs or shell-fish, and other fossil marine objects, which mark at once their ancient oceanic conditions; others contain paludinæ, or river-snails, gigantic bones of extinct reptiles, plants, and minute crustaceans (*Cypridæ*), the relics of

Fig. 3.—Diagram of the Succession of Strata near Pevensey. *a*, Tertiary drift; *b*, *c*, *d*, beds of chalk forming the downs; *e*, upper greensand; *f*, gault; *g*, sand and stone; *h*, pyritous and ferruginous beds; *i*, limestone (ragstone)—lower greensand; *k*, weald clay and sandstone; *l*, bank of beach shutting in estuary; *m*, alluvial or marsh land. The edges of the strata presented at the surface at *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, are the *outcrops*, or *bassetting edges*. The direction-arrow in the chalk (near *c*) shows the *dip* of the strata.

a vastly older estuary. Out of these materials, as out of the river-shells and oyster-banks, the bones, leaves, and canoes of Pevensey levels, we can clearly read the history of past events, and repeople the ancient lands and seas with their ancient inhabitants. We can tell the lines of the old coasts, the area of shallow water, the estuary or river-delta, the region of deep sea. All the evidence is complete; the relics so wonderfully preserved to us throughout countless years—for these surrounding cretaceous and wealden deposits are of primeval date, and belong even to the middle period of geological history—are as uncommingled and as faithfully indicative of the ancient physical conditions with which they were associated and connected.

We can tell the strange kinds of trees and plants which grew upon the old oölitic land before it sank down under the chalky sea; we can trace age by age the old sediments encroaching on the sinking land; we can note every cessation of its downward course; we can perceive the reversal of the movement, and the sea-bottom uprising again as land, every fresh ridge of the ocean's margin receding ever and anon from the wider and wider extended soil, on which new forms of plants and animals appear; until we approach the age of Man, and find his traces, too, and his records added to the ever-changing scene.

Looking backward into the abyss of time, we see older and older of those sedimentary formations—other lands and other seas of still more vast antiquity. We peer into the profundity of the past until we behold, in our mental vision, only low insular specks of gneissic rock; the land's first boss-like crests and crowns peeping above the waves and dotting the wide expanse of an earth-covering ocean, still warm, perhaps, and reeking with the primeval central heat. And then—

> "One vast expanse of liquid green,
> Ocean's self, breaks on the eye
> In inexpressible majesty."

Ever and ever, since the dry land first appeared, has the sea been at its monotonous toil; ever and ever murmuring, surging, undermining, hurling down the earth, night and day toiling and labouring. At work even in its placid moods; when, basking in the sun's bright glittering rays, it lies quiescent without a ruffle on its polished face, with gently heaving breast it idly chafes the pebbles of the shore.

Such is the ceaseless work of the sea, and thus, through countless ages, have the rock-strata of our earth been elaborated.

S. J. Mackie.

WINGLESS BIRDS.

In days; not very remote, there existed several races of wingless (or rather brevipennate) terrestrial birds, spread over different, and, indeed, wide apart portions of the globe. Strange is it that, as far as we can ascertain, none appear to have been natives of the European continent, at least within what we may term a recent period. The catalogue of extant brevipennate birds is not very large, and yet the species are less closely allied to each other than might at first be suspected. How far apart are the ostrich and the kiwi? Yet both belong to the brevipennate type of birds. Look first, then, to Africa and the adjacent portions of Asia; there the ostrich roams the desert, as it did in old historic days. Turn we to the great island of Madagascar; from this island, eggs of enormous size, evidently those of a brevipennate bird, have within the last few years been transmitted to Europe, but whether the bird which laid them be extinct or not, is a problem yet to be solved. At the same time indefinite accounts of one or more large wingless birds, natives of Madagascar, have been transmitted to the scientific bodies of Europe, and it may be that we have yet to become acquainted with some forms whose history will clear up much which is a desideratum to the ornithologist.

It is a wide leap over to South America. This great portion of the globe presents us with two species of *Rhea* (commonly called American ostrich), one of which has long furnished feathers well adapted for making up into light dusting brushes. The second species (*Rhea Darwinii*) was introduced to science by Mr. Darwin, and is a native of the plains of Patagonia. It is there called *Avestruz petise*, while the ordinary species is the *Nandu* of the Brazilians.

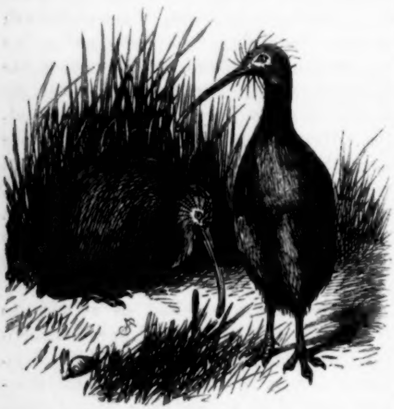
Now for the great Indian islands; they give us the cassowary, and another species recently discovered, namely, the mooruk (*Casuarius Bennettii*), of which a pair are now living in the gardens of the Zoological Society.

Sail we thence to Australia; there we find the emeu (*Dromaius Australis*, Swainson), the relict, most probably, of other brevipennate birds. Let us next glance at the islands now called Mauritius, Bourbon, and Rodrigues. Here existed, until the middle of the seventeenth, or beginning of the eighteenth century, the dodo, the solitario, and, as we have reason to believe, other brevipennate birds, whose extinction, partly, no doubt, by the agency of man, has been marvellously sudden. But, so it strikes us, man could not have altogether accomplished this sudden and total extirpation; and are we not here reminded of those cycles in the lapse of time wherein races become *effete*, extinct, leaving vague traditions of their former existence, with the attestation of their semi-fossilized bones?

These observations lead us at once to New Zealand. The fossilized, or rather semi-fossilized, bones of apterygious birds of gigantic size, prove that at no distant date—nay, even since a wandering Malay population made good their ground upon these islands, till then probably untenanted by man—many species of wingless birds, some far larger and heavier-boned than the ostrich, roamed over hill and glade, and trod down the fern-brakes with heavy footstep. Have they, these *moas*, been extirpated by man, or have they fulfilled their allotted period? No *indigenous* quadrupeds tenant these islands. Did the Malay race destroy them, and then, for want of other food, take to the system of cannibalism? We cannot think so. Cannibalism has long existed in other islands where such horrible necessity could not have been

felt. The Pelagic Malays, as their annals prove, however, had a cannibal propensity. Be this as it may, the giant moas have but recently passed away; but, as with the great megatherium and the mylodon, monsters of the sloth tribe in the primeval forests of America, they have left a few pigmy representatives, lingering on the verge of extinction, but not yet quite extinct.

New Zealand presents us with a wingless gallinule—a semi-water bird—a sort of moorhen (*notornis*), probably the remnant (if indeed it still survive) of other wingless birds of the same type. *New* Zealand seems to



have been the *dilecta sedes* of brevipennate birds. But our attention is at present called to the pigmy representative of the moas. There still exists a bird called the kiwi, or kiwi-kiwi (*Apteryx Australis*), and the following notes were made upon a living specimen, which came under our immediate inspection. It was a singular, unbird-like looking creature. Huddled up in the dark corner of an appropriated room, there we beheld it crouched close to the ground, with its long cane-like beak, supporting crutchways the head and anterior portion of the body. Annoyed by the light which we let in upon it, it became restless, altered its position, and then, raising itself upright after the fashion of a penguin, it moved hurriedly to a more secluded spot. It was then that its remarkable length of body became manifest, which in its previous crouching and rounded attitude was not observable. Its actions during its endeavours to regain obscurity were vacillating, as if it did not clearly distinguish surrounding objects, nor even the surface of the floor over which it essayed to make its way. We at once perceived that its diurnal vision was both imperfect and limited—it seemed bewildered. Having gained, like a thing suddenly roused up from torpor, its dusky retreat, it again assumed its strange attitude of repose, but less completely than before; for, although it crouched and pressed the point of its beak to the floor, it occasionally raised the head a little, inasmuch that though the beak pointed downwards, it did not form a prop. Its disturbance seemed more to arise from the unwelcome light than from our presence; it exhibited no terror, no extraordinary agitation, for, vacillating as its movements were, it did not dash wildly about, nor did it utter any sound or cry; in fact, it exhibited the extreme of apathy. We did not see it during the night, but we were assured that it then roused itself up, and bored continually into a large artificial earth-mound in quest of worms, of which it had an abundant supply. Of its intelligence we formed but a low opinion. Do not creatures of the lowest cerebral development—we speak here of mammals—pass away the first, and give place to a higher race of representatives? Was the densely fur-clad mammoth of Siberia equal to the "reasoning elephant" of Ceylon, or of intertropical Africa?

On such a subject all speculation is futile—only we know that the marsupials, once extensively distributed, are now confined to Australia, their stronghold, and to America. In these we have the lowest of mammalian

cerebral development. Fossil relics show how numerous they must have been, and not a few existed even in Europe at a prior condition of our earth's surface. They are lingering, and so are the terrestrial wingless birds. The kiwi treads upon the edge of the precipice.

Let us return to our notes. On looking closely at the kiwi, certain peculiarities, irrespective of its rudimentary wings, and the long, slender, lanceolate feathers, with which it is clothed, attracted our notice. Above and below the eye, at the base of the beak, and on the forehead, are groups or pencils of long whisker-like hairs. Now, if we consider for a moment the habits of the kiwi in its native regions, where, by night, it winds its way amidst the dense fern-beds, bores into the ground, and seeks shelter in deep excavations, we may, perhaps, not err if we attribute to these bristles a use similar to that of the whiskers of the cat, and other nocturnal quadrupeds—may we not reasonably suppose that they serve as feelers, and thus prove aiders to the sense of sight?

Another peculiarity was the smallness of the eye, so contrary to what prevails in birds of nocturnal habits, such as the owl, the woodcock, the snipe, and thickknee, which feed by night. These, however, are birds of flight. The kiwi is not; its locomotion is restricted, and it probably requires a less range of vision amidst the deep fern-brakes which enshroud it, although the power of nocturnal sight within a limited range may be very, or even microscopically, acute. The admission of a volume of such light as the night affords, and for which the eyes of the owl and thickknee are adapted, if admitted to impinge upon the retina of the kiwi, might dazzle and bewilder the bird. This, in fact, would appear to be proved by the circumstance that the natives hunt it, during the hours of darkness, by the glare of torchlight, which, while it betrays the bird, at the same time confuses and bewilders it. Professor Owen observes, that in the kiwi the organ of vision is at a very low ratio of development, and that the eyeball is relatively much smaller than in other birds, but the cornea is very convex; on the contrary, the olfactory system is larger than in other birds; and he remarks, that the nocturnal habits of this bird, combined with the necessity for a highly developed organ of smell, which chiefly compensates for the low condition of the organ of vision, produce the most singular modifications which the skull presents, so that it may be said that those cavities which in other birds are devoted to the lodgement of the eyes, are in the *Apteryx* almost exclusively devoted to the nose.

The iris, as we particularly noticed, is dark brown, and the pupil minute, at least by daylight.

In most birds, the nostrils are placed at or towards the base of the beak, or rather upper mandible; in the kiwi their situation is most singular; they appear as minute, narrow fissures, placed one on each side of the tip of the upper mandible, which is at that part somewhat swollen and notched; a furrow runs from the base of the mandibles to the linear nostrils. The internal olfactory apparatus and the pituitary surface, on which the olfactory nerve freely ramifies, is complex and extensive; hence the acuteness of the sense of smell, on the exercise of which this bird so greatly depends for obtaining its food.

There is another point in the kiwi which cannot but strike every one who sees it in its erect attitude—we allude to the vast muscular development of the thighs, as they are popularly called, by which the assumption of this attitude is rendered easy. The tarsi are short and stout, the toes are four in number, without any intervening webs, the three anterior are strong, and armed with powerful claws, well adapted for the excavation of burrows. The hind toe is very

short, and terminates in a sort of spur, of a conical figure. With this spur, and the anterior claws, the kiwi is said to defend itself very vigorously, striking with rapidity, and a degree of force proportioned to the vast muscular volume of the thighs.

It is said that the kiwi is in the habit of stamping upon the ground, in order to disturb the worms, which it seizes with its beak the instant they make their appearance. But we doubt this; the limbs, as the bird stands upright, do not seem to be adapted for this sort of action, nor did the mound of earth, bored all over by the creature's long bill, exhibit any traces of this stamping operation. A similar habit has been attributed to our lapwing, but no one who has studied the economy of this lightly-tripping bird can, upon consideration, believe that the stamping powers of its feet are so energetic as to alarm the worm in its retreat.

With respect to taste in the kiwi, we may presume, from the connection of this sense with that of smell, that it is tolerably acute. Although the tongue is short, it is more developed, according to Professor Owen, than in any of the ostrich group.

The sense of touch probably resides, to a considerable degree, in the tip of the beak, but of this we cannot speak positively, nor do our observations enable us to state any decisive opinion as to the perfection of the sense of hearing, although we may infer from the habits of the kiwi that this sense is as acute as in the ostrich or cassowary.

The natives highly value the skin of the kiwi, which is made into dresses and mantles, with the feathers on, and which the chiefs wear by way of distinction. Dogs are employed in its capture.

Mr. Gould describes two species of kiwi, or, as the natives, doubling the word, term it, kiwi-kiwi; viz., *Apteryx Australis*, the species recently in the gardens of the Zoological Society, and *Apteryx Owenii;* but a larger species is found in the middle island of New Zealand, and called by the sealers the Fireman.

The first, and we believe the only notice of this bird, appears in a communication to Mr. Gould from Mr. F. Strange, from which we take the following extract:—"I am told that a second species of Apteryx is to be found on the middle island, that it stands about three feet high; it is called by the sealers the Fireman. Aware from your figures and description, that the sexes differ considerably in size, I pointed this out to my informant; but he still persisted that there are two species, in confirmation of which opinion, he added that he had taken the eggs of the two birds, and found those of the one species to be much larger than those of the other. The larger kind are nearly the size of the emu's; they are somewhat long in form, and blunt at the ends; their colour is dirty white. They are deposited in a burrow, on a nest formed of roots and sticks, and a few of the bird's own feathers."—*Proc. Zool. Soc.*, 1847, p. 51.

Of this species we have no detailed information; but its alleged size prevents our regarding it as identical with *Apteryx Owenii* (Gould), which is not larger than *Apteryx Australis*, being only eighteen inches in length, from the tip of the beak to the end of the body.

Speaking of this bird, a specimen of which he received from New Zealand, by way of Sydney, unaccompanied by any information as to the locality in which it was procured, or any particulars of its habits or economy, Mr. Gould says: "It appears to be fully adult, and is about the same size as the *Apteryx Australis*, from which it is rendered conspicuously different by the irregular transverse barring of the entire plumage, which, with its extreme density and hair-like appearance, more closely resembles the covering of a mammal, than that of a bird; it also differs in having a shorter, more slender, and more curved bill, and in

the structure of its feathers, which are much broader throughout, especially at the tip, and of a loose, decomposed, hair-like character. The wing is even more rudimentary than in the *Apteryx Australis*."—*Proc. Zool. Soc.*, 1847, p. 93.

When Mr. Strange wrote, he was unacquainted with the existence of the *Apteryx Owenii*, and therefore speaks of his Fireman as "a second species;" but when it comes to be accurately known, it will form the third.

The eggs of the *Apteryx*, as more recent discoveries prove, are of large size, compared with the body of the bird, and the young are hatched with complete clothing, and capable of using the beak and legs with due effect, reminding us in this respect of the mound-making birds of Australia.

W. C. L. Martin.

THE "CONSECRATIO" COINS OF THE ROMAN EMPERORS AND THEIR FAMILIES.

IN TWO PARTS.—PART I.

Among the fine series of Roman coins known as the "large brass," none are more interesting than those technically termed the "consecratio" coins. These remarkable pieces of money, struck to commemorate the apotheoses of some of the Roman emperors, and other members of the reigning families who successively occupied the imperial throne, are frequently of very fine execution, and generally bear some very striking, and more or less symbolic device. The magnificent funereal rites lavished on the remains of the great or powerful, have, from the earliest times to the decline of Paganism, been of an impressive character, and have, more or less, according to the manners and genius of the people, embodied some of the leading religious convictions of the time. In the space, however, of a short detached article like the present, it would be impossible even to allude to the rites connected with the interment of the dead, as practised among the Egyptians, Assyrians, Jews, or other ancient peoples. But in order to exhibit and explain the source of the earliest devices used on the consecrational coins of the Romans, it will be necessary to allude, in some detail, to the funereal honours paid to the remains of Alexander the Great, which were performed under the auspices of the first Ptolemy, King of Egypt, the earliest occasion known on which coins were struck in commemoration of such an event, and bearing a device connected with some of its leading features.

After the death of the Macedonian conqueror, at Babylon, in the year 323 before the Christian era, the vast possessions subdued by the Grecian arms were seized upon by his powerful lieutenants, to the prejudice of his infant son by the celebrated Roxana, and in defiance of the efforts of his half brother, Philip, who had been appointed regent. Egypt fell to the lot of Ptolemy Lagus, who succeeded, partly by superior diplomacy and partly by force, in retaining permanent possession of that noble province. In order to give a colour to his assumed right as the successor of Alexander, he conceived the idea of claiming the remains of his former sovereign, for the purpose of depositing them in the city which he had founded, and which bore his name. The demand was the more plausible, inas-

much as in founding the city, which he named Alexandria, the Macedonian prince had evidently intended it to form the metropolis of his vast empire; for which purpose its situation at the junction of Asia and Africa, and its power to command the south and east of Europe by fleets issuing from the great naval nursery of the Nile, rendered it admirably fitted. In that city, therefore, as a last token of respect to its great founder, Ptolemy proposed that his remains should be deposited, rather than at Ægas, the ancient burial-place of his ancestors in Macedonia.

The ulterior views of Ptolemy in obtaining possession of the remains of Alexander were probably not perceived by Archidæus, who had been charged with the direction of the obsequies, and no opposition was made to the demand of the ruler of Egypt. Archidæus, and those in power in Asia, were possibly rejoiced at being rid of the expense and responsibility of superintending the obsequies of their great leader, and the imperial remains were, therefore, transferred to Alexandria, where the obsequies were performed, under the auspices of Ptolemy, with extraordinary splendour.

We learn from Callixines, of Rhodes, in a passage preserved by Athenæus, that the great procession was closed by a magnificent car, drawn by elephants, in which was placed a golden statue of Alexander. This car, the elephants, and the golden statue of the conqueror are accurately represented in the coin engraved above, one of those which were struck by order of Ptolemy to commemorate the event. The figure of Alexander is represented holding a fulmen, or thunderbolt, either in token of his deification after death, or in allusion to the descent from Jupiter Ammon, to which he had laid claim. It was most probably in the latter signification, as the deification would only have taken place after his death, whereas

he had been represented in the same manner during his life-time, especially in the famous picture in the Temple of Diana at Ephesus, to which M. Longperrier alludes in his instructive essay on the Ptolemaic coinage. The inscription above the car is "ΠΤΟΛΕΜΑΙΟΥ ΒΑΣΙΛΕΩΣ" ("of the King Ptolemy"), meaning money of the King Ptolemy, for he had already assumed the regal title, and that is the usual form of inscription on the money of all sovereigns of that epoch. On the obverse is the portrait of Ptolemy, without any inscription. The head is very fine, and represents the king in the flower of his age, the features, however, showing a striking resemblance to those of the monetary portraits found on coins issued at the close of his long reign, when he is represented as at an advanced age. I merely mention this fact to show that the portraits of princes on ancient coins of that comparatively remote period, were evidently executed with great care and accuracy, and that a most interesting portrait-gallery of historical characters has thus been preserved on coins when every other record of their form and feature has been swept away. The gold coins struck to commemorate the obsequies of Alexander appear to have been of unusual weight, the one from which the above engraving is made is apparently a hemistater, but weighing 109½ grains, while to the attic standard, to which the famous gold coinage of Philip of Macedon was adjusted, only 66 grains were assigned to the half stater. It is true that the Greek sovereigns of Egypt, in order to acquire popularity, and a reputation of great wealth, issued gold money of the *ancient* Macedonian standard, which was much heavier than the Athenian, and it might be supposed that the present coin was of that standard; but it is, in fact, still heavier, and was, doubtless, issued of such great additional weight in honour of the special occasion to which its device refers.

No other consecrative coin of this kind

occurs in the Egyptian series. A coin struck by Ptolemy Philadelphus, the son of Lagus, is, however, of a somewhat analogous character. Philadelphus succeeded to the throne on the abdication of his father, after whose death he caused a coin to be struck in his honour, and also in that of his mother Berenice. On this coin—which may perhaps be termed a "consecratio" coin—like those of the Romans about to be described, the portraits of Ptolemy the First, and that of his last queen, Berenice, the mother of Philadelphus, are represented in profile, one over the other, accompanied by the inscription ΘΕΟΙ, gods, in token of their supposed reception after death among the deities of the Grecian mythology. This is, therefore, a coin of somewhat similar character to those long afterwards struck by the Romans, at the time of the apotheosis of certain emperors; for that the "apotheosis" of Ptolemy was a deification of precisely analogous character we learn from the pastoral poet Theocritus, in his 17th Idyl.

In the year 14 A.D., just 337 years after the death of Alexander the Great, died Augustus Cæsar, the first Roman emperor. His successor Tiberius, and a servile senate, decreed to him a place among the gods, and on a simultaneous issue of the public money were stamped appropriate devices to commemorate the deification. Alexander of Macedon was still the hero-type emulated by more recent rulers, especially by Augustus, though he may be said to have been rather the Alexander of peace than of war—what Alexander might have been, after the consolidation of his conquests, had he not been prematurely carried off by disease, instead of reaching a ripe old age like his Roman successor in the empire of the world. However this may be, Augustus had evidently wished his name to be associated with that of Alexander, as a ruler over equally vast possessions, and the senate hastened to flatter this predilection of their dead emperor and his successor, by causing coins to be issued in commemoration of his obsequies, precisely similar in device to those struck by Ptolemy at the funeral of Alexander. The Roman device was, however, made more splendid; the increased dimensions of the large brass coinage affording more scope to the designer than the limited space of the small gold pieces issued at Alexandria. Instead of two elephants, *four* were yoked to the car (as represented below), the car itself being

also of more splendid structure, with a kind of stage on the top. It is, in fact, the peculiar kind of car called *Thersa*, which was only used for the purpose of conveying the statues of the gods to the circus, on the solemnization of the sacred games. The statue of Augustus is in the exact position of the sitting figure of Jupiter, which is found on the silver tetradrachms coined in the reign of Alexander the Great, even to the chair or throne, which is accurately copied in all its details. Above the elephants, instead of an inscription, merely containing the name and title of the reigning sovereign, as on the Egyptian coin, the following legend is placed, DIVO AUGUSTO S.P.Q.R., which at length should read, DIVO AUGUSTO, SENATUS POPULUS QUE ROMANUS. To the Divine Augustus, The Roman Senate and People.

It has been said that the elephants were adopted in this device as being typical of dignity and eternity; of dignity on account of their size and stately walk, and of eternity

from the great age to which they live, which often exceeds 300 years. But it is much more probable that in this instance they were merely adopted as symbolical of conquests in the East, as was usual in that age. It is true that in India the elephant has been from remote antiquity a symbol of royalty, and strength, and eternity; but the Romans had probably no such theory in view, and were possibly altogether ignorant of the symbolic and semi-sacred character conferred on these animals in central India.

But there *is*, nevertheless, a symbol of eternity represented on this coin, which consists of the crown of rays worn by the emperor. Representatives of emperors were, during the early periods of the empire, never crowned with rays till after deification, that kind of coronet being precisely analogous to the celestial crown of modern heraldry; but it was afterwards assumed by the Roman princes during their lifetime. The statue holds in its left hand the *hasta pura*, or unarmed lance, as an emblem of peace. The reverse of this coin has in the centre two large capital letters, S. C., for *Senatus Consultu* (by decree of the senate), and the name and titles of Tiberius.

The apotheosis of Julius Cæsar had been previously commemorated in a somewhat similar manner by Augustus and the senate, by the issue of a special coinage, which, however, did not bear any device of the usual character of the Roman "consecratio" coins of the regular types, and I have therefore not engraved it. Yet it may not be irrelevant to refer to it in this place, as recording the appearance of a natural phenomenon which occurred at the time, and gave additional force to the superstition concerning the ascent of the spirit of Cæsar to take its place among the gods. During the games established in honour of the deified Julius, a comet of unusual brilliancy was observed, which remained visible, even in the day-time, for seven days. This was, of course, believed to be the spirit of Cæsar ascending to its place among the constellations, and it was therefore represented on some of the commemorative coins then issued. It was the Julium Sidus of Horace, the Cæsaris Astrum of Virgil, and was mentioned also by other writers of the time. Sir Isaac Newton conjectured that it might have been a previous appearance of the great comet of 1680, as the time agrees tolerably well with one of its periodical visits. But some of our modern antiquaries have thought that the star represented on the coin does not refer to a comet which had just appeared, but merely to the planet Venus, in allusion to the pretended descent of the Julian family. This supposition is rendered somewhat plausible by the fact that the planet Venus is, in the south, often visible during the day, and may have been especially observed to be so at the time of the death of Cæsar. I am, however, inclined to think that the object on the coin is intended to represent the comet which then appeared, though it does not bear a very accurate resemblance to an asteroid of that class. The Roman theory of this enrolment of a mortal among the gods was not very dissimilar to that of canonization of saints in the modern Romish ritual; the Christian canonization being possibly but a continuation of the Pagan apotheosis, like many other forms still retained in the unreformed Church. The term, as used among the Romans, did not mean simply the elevation of an emperor to divine honour by his successor, and his formal enrolment among the gods, but was an indirect expression of the national belief of the immortality of the soul, which gives to the monuments connected with the ceremonial of consecration a far deeper interest. It was, in fact, the popular creed of the Roman people that the souls, or *manes*, of their ancestors became deities, and in this feeling it was that the *manes* of parents were worshipped by their children.

H. Noel Humphreys.

THE GREEN TREE-FROG.

MANY years ago I made a note of the green tree-frog, as one of the desiderata of my little collection; and, though I inquired often, I never succeeded in obtaining it till this time last year, when a kind letter from a lady informed me of the offer of three fine specimens. I lost no time in accepting the gift, and in a few days they were safely domiciled with me at Newington. I have derived so much amusement from my "sticky-toed" friends, that I believe a brief account of them will be interesting to students of natural history generally, and especially to that section of them who delight in aquaria, and kindred homely pursuits.

There are several species of frogs which may be collectively described as "green," but the green tree-frog is most distinct in appearance and habit from all the marsh-inhabiting ranæ, for it is amphibious in only a qualified degree, and, as its name implies, it lives very much among the branches of trees. It is known among naturalists as *Hyla arborea*, sometimes as *Hyla viridis*, on account of its bright green colour. It is a native of France and Germany, hence readily adapts itself to the climate of this country, and will, perhaps, some day be acclimated as an addition to our fauna. The only difficulty apparent at present, in regard to its permanent location in Britain, is the variableness of our climate; for this frog becomes thoroughly torpid in winter, and for that reason continued cold weather is congenial to its constitution. The occasional outbursts of sunshine with westerly winds in winter disturb its hybernation, and make it active at a season when it ought to be at rest, and hence it is just probable that it may never become a permanent resident in these islands.

Leaving that point to be determined by experience, let me call your attention to the pretty creature here figured. His colour is vivid emerald green over the whole of the upper surface of the body, with the exception of two black marks, which extend from the eyes to the inner side of the shoulders. Beneath, his colour is a greenish white, and the skin is semi-transparent, and of a most delicate texture. The eyes are prominent, and of a lustrous black, as beautiful, indeed, as the eyes of a toad, which, to my think-

ing, are among the most beautiful of all the eyes in creation, except, of course, the eyes through which a human soul peeps. *Hyla arborea* has a particularly neat contour, full-grown specimens are not more than half the size of the common frog, but the structure is more compact and graceful; and when in activity, the long legs and button toes indicate at once its chief characteristic, that of climbing and leaping. The activity of the creature adds to the interest we derive from

its beauty when kept as a pet. Its habit is to sit perfectly still on the summit of the rockwork in the glass, or on a flat leaf of a plant when set at liberty in a greenhouse; but the moment a fly passes, it wakens up, becomes restless, and screws its legs together for energetic action. Fixing its beautiful eyes on a buzzing bluebottle, froggy waits his opportunity, and presently at one spring he pounces on the victim, and swallows him whole. The bluebottle goes buzzing to its sepulchre. It is in this lively method of taking its prey that we are enabled to note particularly the manner in which this frog is equipped for the curious life it leads. The toes are all furnished with suckers, which enable it to hold firm to whatever object it may alight upon, so that though it may miss the mark of its appetite, as sometimes happens, it never falls or loses its balance, but is instantly at rest on some kind of support, and as immobile as if nothing had happened.

Hyla arborea has all the ordinary characteristics of a reptile, though possessed of considerable individuality. The hybernation is quite of the reptile type, and the changing of skin takes place in precisely the same manner as in the common toad. The creature first changes colour, and becomes mopish. The vivid shining green gives place to a dark hue, which, as the time of exuvation approaches, deepens to a bottle-green. In a day or two he is again as bright and lively as ever, sporting a new jacket; his eyes have a fresh sparkle, and his appetite is so keen, that the flies can no longer crawl over his nose with impunity—they are pounced upon and bolted, the moment they come within reach of his spring. One thing strikes me as worthy of special notice, and that is, that the flies have not the least sense of danger, and make towards him as they do towards glistening objects generally. The instinctive fear of enemies is a common fact in the natural world, but between Hylas and his proper dinner there is no evidence of its existence, the dinner may, when he is in an idle mood, playfully tickle the nose that is presently to recognize its savour.

Though it delights in water, and needs to have it always within reach, it is in summer-time but partially amphibious. It will now and then swim round, and then ascend the glass, where it will remain motionless for hours, holding tight by means of its toe-suckers and the delicate membrane of the stomach, which indeed it depends on chiefly when attached to a smooth surface. Being quite familiar with its history long before I obtained specimens, I prepared a cage of wire gauze to stand on a glass dish for them, when the three were presented to me. Unfortunately, I trusted the manufacture of the cage to a man who had neither brains nor fingers, and the result was, that having given them a branch to climb upon, a supply of water, and a piece of rockwork rising out of it, two made their escape the same night through a gap in the wirework, and were never heard of more. The cage was then cast aside, and the lonely representative of his race transferred to a bell-glass, neatly prepared for him with pebbles and rockwork. A small flower-pot was made the basis of the rockery, and on it was fixed, with plaster of Paris, some small pieces of broken burrs, so as to form a pyramid. A ten-inch bell-glass gives him plenty of room, and escape is prevented by covering the top with the wire gauze lid of the disused cage. Once or twice a week Mr. Hylas has liberty to leap about and climb the windows, where he catches flies for himself. Meanwhile, the rockwork is lifted out, the pebbles washed, and the glass cleaned, and the whole made bright for his reception again. He has become very tame, and will sit on my finger, and leap from it when the buzzing of a blow-fly makes him for the moment a sort of aerial tiger; then his quickness of sight, and spasmodic rapidity of action are indeed amusing. Ordinarily,

flies are caught and put in for him, but he will never touch a dead one, and, like a toad, will only take them when he sees them move, and then it is accomplished instantaneously. When not hungry, he allows any poor winged captive that may be wandering about, "waiting to be eaten," to walk over him and tickle his nose to any extent—he takes no notice, and, without moving a limb, goes on with his palpitation, which is the only sign given that he is still alive. This curious throbbing action of the gullet denotes the activity of the respiration in these frogs. But they breathe through the skin over the whole surface of the body as well, and hence, if kept immersed in water, with no means of escape, soon perish by asphyxia.

Last autumn I followed the advice given by Mr. Thompson in his "Note Book of a Naturalist," and saved for my pet some dead flies for winter food. Mr. Thompson says he kept one in a vase for six years, and in the winter fed it with dead flies, moistened with warm water, "which it took freely from the fingers." But my specimen would not take them during the winter, though I repeatedly presented them, and sometimes gave them a tremulous motion with my fingers, in hopes he would imagine the fly to be alive. But the attempt was as unnecessary as it was futile. From November till March he ate nothing at all, and after the first fly had been caught and given him he became as active as ever. Like most other reptiles, the more complete their hybernation, the more certain are we of preserving them in health. When my bees began killing the drones last year, I gave my pet a handful of the helpless creatures, and he devoured them wholesale as long as they had any amount of activity. The drowned drones had, of course, to be cleared out quickly, or the vase would have looked most unsightly.

To the loss of the two specimens I attribute the fact that I have never yet heard the music of this frog, which is said to be most discordant, and by no means deficient in volume. Mine has been a perfect mute; but I apprehend that when several are kept in company, the social feeling finds utterance, but they have too much sense to croak when there are no companions to join in chorus. Should I ever be so fortunate as to meet with a benefactor equally liberal with the one to whom I am already indebted, I shall expect to make acquaintance with many interesting points in the history of this pretty Rana, which, like the music, need companionship for their development. I know of several collections of them, but the parties are not so well stocked that I would venture to ask for gifts.

SHIRLEY HIBBERD.

DEATH AMONG THE GOLD-FISH.

WHEREVER you meet with folks who keep gold-fishes in the old-fashioned glass globes, you will be sure to hear the melancholy complaint that they *will* die in spite of every care taken to preserve them. The water is changed most regularly, the glass kept beautifully clean, the vessel shaded from the sunshine; yet, alas! alas! death is always busy amongst them. Is it internal disease? Is it external fungi? No; the cause is *starvation*. Every other pet is expected to eat, but these gold-carp are expected to subsist on—nothing! "But don't they eat the animalculæ?" Nonsense! Give them a few small earth-worms, or anglers' gentles, twice a week, and to prevent the necessity of frequently changing the water, throw in a handful of Anacharis (water-weed); and, instead of floating in succession "on their watery bier," they will get plump and healthy, and grow as rapidly as in their native waters. Some of our gold-fishes have been in our possession seven years, and have increased in size three times what they were originally. H.

WAYSIDE WEEDS AND THEIR TEACHINGS.

IN SIX HANDFULS.

HANDFUL I. CONCLUDED.

THERE remains yet, for examination, one other part of the flower. Exterior to all the organs we have hitherto described, you cannot fail to have noticed a covering, or set of coverings, to which, as they hold the blossom generally, botanists have given the name of calyx, or flower-cup (Figs. 2, 3, 9, 16, 19, 20, 21.) This calyx, moreover, has its many differences, even in the limited number of plants we have as yet examined. It is divided, in most of our examples, like the corolla, into separate pieces; and as the divisions of the corolla are named petals,

FIG. 19.—*a*, calyx or flower-cup of stitchwort; *b*, stamens.

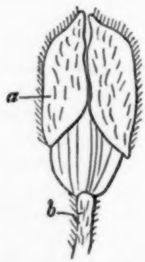


FIG. 20.—Expanding flower of common poppy, throwing off calyx, *a*.

so are those of the calyx called *sepals*. Generally speaking, the calyx, or flower-cup, is green, but we see it in the wallflower (Fig. 7) more or less deeply coloured; and in the buttercup (Fig. 2) yellowish in hue. Frequently the number of the sepals, or calyx divisions, corresponds to those of the corolla, but not invariably, as we see in the poppy (Fig. 20), in which there are but two divisions, and these joined at the top, more or less completely. Moreover, this poppy calyx does not, as in the wallflower, the chickweed, the violet, or the geranium, continue attached to the flower, but is cast off while in the process of floral expansion.

Calyx, corolla, stamens, pistils—these, bear in mind, are the parts of a *perfect flower*, which always preserve the same relative positions within one another. With the exception of the lychnis, already noticed, you will find it so in every plant in our Handful. To make sure, look at the bright white, well-named starwort, or stitchwort, which we have not yet noticed; all the parts are just as you have seen them in the rest. Differing in many respects, in this all our plants agree—*the petals are perfectly disconnected from one another, and from the stamens, and with the stamens are fixed to the little receptacle on which is placed the pistil.* Now these *characters*, as we call them, though apparently unimportant to a superficial observer, are far from being so to a botanist; they mark, in fact, one division of botanical arrangement—a division, moreover, which comprises within its limits many other plants and families of plants beyond the few common weeds we have selected as examples. The buttercup or crowfoot family, or, as it is called botanically, the Ranunculus genus, is made up of numerous individual members, all differing from one another, but yet bearing the general family face. Some so like that you will not distinguish them till the difference has been pointed out; others, though similar, still so different, that you cannot mistake them for each other.

You have, in all probability, gathered into your handful at random, a lot of what you call buttercups; they have all flowers

about the same size, with bright yellow shining petals, and look as like as possible; but take this one, which you gathered in the meadow—if you have got it up by the roots (*as you ought to do every plant*, the size of which in the least admits it)—you find that it has a bulbous swelling root, that its stem is upright and hairy, and its calyx sepals are turned back (Fig. 2) from the fully-expanded flower. This, which is the ranunculus bulbosa, or bulbous-rooted crowfoot, put beside the other which is in your Handful, and which, when you gathered it, you thought was precisely similar. Compare the flower-cup (Fig. 3) with the last. It spreads—in old blossoms it falls off—but does not turn down, even in the fully-expanded flower, its root is not bulbous, and attached to it are side-stems, *scions*, which rest on or run along the ground. This is the ranunculus repens, or creeping crowfoot; and no less different is this third species, the ranunculus acris, or upright meadow crowfoot, which very likely grew beside the other two, and which, just as likely, you took into your Handful in perfect innocence of any difference. It, too, has a spreading, and not a turned-back calyx, but it has no *scions*. Make another comparison of these three near relations; their faces are all very similar, are they not? Look at the little stems, *peduncles*, which support the blossoms. In the first two species you examined, the bulbous and creeping crowfoots, these stems have little channels or furrows cut on their surface; in the last, the upright crowfoot, they are mostly rounded. Pray look over these little distinctions again, get them into your memory, and tell us, could you mistake these plants for one another again? Quite impossible, for small as the marks of difference may be, *they are constant*. Lastly, get into your mind an idea of the general appearance of these plants—the general *habit*, as botanists call it—and you will have achieved a practical lesson in plant lore which will not readily be forgot. The above are three of the crowfoot family, with a strong resemblance; but there are many of the same family, or, let us designate it properly, *genus*, very different; some have comparatively small flowers, and some are white, as we find in the common water ranunculus, which is so common in every streamlet and ditch that it well deserves to be called a wayside weed. Look now at the leaves, not the petals, but the plant-leaves, of

FIG. 21.—Leaf of Common Buttercup.

the buttercup race, with which we have just scraped acquaintance; they are all divided more or less deeply (Fig. 21), but we find others with leaves perfectly undivided: these are the spearwort ranunculuses, and one of them you may gather at the side of almost any pond. The buttercup-like flower of the spearwort you cannot mistake. One word more about our friends before we part. The members of the buttercup genus are most eloquent expositors of many botanical facts, and

you are now in possession of the key to some of their peculiarities. If you use your eyes you cannot miss finding species different from those most common ones upon which we have founded our first lesson. Gather all you can; never mind, at first, if you do not know their names, but put them together, and compare in every part—leaves on the stem, and leaves springing from the root-crown, hairs or no hairs on any part, pistils plain or otherwise. These exercises will teach you how to look at plants, and make the very commonest weeds convey as much instruction as you could get from the rarest exotic. We have dwelt somewhat upon this ranunculus family, not only because of the well-marked characters of its members, but because so many of them are familiar to us all from childhood, and meet us in every country walk. We must now say adieu, and look to the rest of our Handful.

Take another look at the poppies. You could not mistake a poppy, putting colour out of the question, for a buttercup. The petals composing the corolla are separate; it is true the stamens are numerous, and both are attached to the flower in the same manner as in the ranunculus, but here the resemblance ends. The calyx, as we have seen (Fig. 20), is entirely distinct, both in its divisions and in its development, and the round central pistil in one piece of the poppy (Fig. 6) is abundantly diverse from the many pistils of the ranunculus (Fig. 4). There are many other differences, which at present we are not prepared for.

We go to the wallflower (Fig. 7), the water-cress, or the charlock (Fig. 15), all plants of the same great botanical section as the ranunculus and the poppy; that is to say, they have many-petalled flowers, and petals and stamens (Fig. 14) are similarly attached; but how different are they otherwise. The petals are clawed (Fig. 8), the stamens are definite in number, not many, and the central pistil is altogether dissimilar, as we shall see more clearly when we come to examine our basket of fruits. Now, the wallflower, the water-cress, the wild mustard, and many similar plants, belong to a most important family, called the Cruciferæ, or cross-like plants, the petals being arranged in the shape of a cross, as a very little examination will show. Turning for a moment from wild to cultivated plants, you will find the characters of the crucifers well marked in any turnip, cabbage, or radish, which may chance to run to seed in your garden. In an economical point of view, there are few plant families more valuable to man than these crucifers.

Buttercup, poppy, wallflower, each types of their own particular family, have regular flowers; you can divide them in any direction through the centre into two equal halves. Not so our sweet little violet (Fig. 22), which holds its place beside them. It, too, is many-petaled, and has stamens and petals attached like the others, but its flower is irregular; to divide its five petals equally, you must cut the centre in one direction only. The stamens and pistil, a single glance will show, have their distinctive marks.

FIG. 22. — Blossom of Violet. *a*, corolla; *b*, calyx; *c*, peduncle or flower-stalk; *d*, bracts; *e*, spur of corolla.

The lychnis, stitchwort, and chickweed bring us back to the regular flowers. The stamens (Figs. 16, 19) are more than in the wallflower, fewer than in poppies or buttercups. The petals are clawed (Fig. 10), the shape different, and, specially, the pistil (Figs. 17, 18) differs from the plants we have already examined.

Lastly, take the common wayside geranium (Figs. 11, 12), which we gathered into our Handful. Still we find the distinct petals attached with the stamens as before, only, at

the base of the latter we come upon something new, the organs are united just in the reverse to those of the violet. The pistil, with its five lobes at the base, and its long beak, is very different from any we have yet met with, and with it we have arrived at the end of our first gathering. Just let us review what we have learned from it. We began, supposing that we knew nothing whatever of plants, and that all the stock of knowledge we had to start with was the recognition of the very commonest weeds of the wayside. Those which we selected for our first lesson were taken because of the one common character so often alluded to, the attachment of the distinct petals and the stamens to the organ named the receptacle, which supports the pistil. We have seen that but for this common character they differ widely, and we have learned, at the same time, what are the parts of which a complete and perfect flower is composed, namely, the calyx and its sepals, the corolla and its petals, the stamens and the pistils, and these organs we now know, and look for in a special order. Enough here for one lesson, albeit we have a much better capital of information to start with when we go forth in search of a Second Handful.

SPENCER THOMSON.

HUMBOLDT.

IN TWO PARTS.—PART II.

HUMBOLDT AT BERLIN.

THE Life of Humboldt, like a term at college, naturally "divides" at a certain period. We have seen him collect his material, and digest the substance of his great work. His fame has culminated. His presence is everywhere sought for. Men who could not appreciate his scientific foresight or his brilliant suggestions, could yet believe in results. "*Rien ne réussit jamais comme le succès,*" says the French proverb. "There's nothing in the world half so successful as success," cry the Americans, endeavouring to translate the untranslatable. He, who had been laughed at for a visionary when he sold his estates to procure means to explore the New World, was now declared to be the wisest of mankind! He who had been a mere *savant*, an idéologue, was now consulted on statecraft no less than upon geology—was thought to know something of the government of the world, since he had learnt much of its formation, and was brought from his study to be the privy councillor of his sovereign. Let young and ardent spirits take comfort as they think of this. Persevere; have one idea, be true to it, follow one, act by another; have will, determination, and purpose, and, with God's blessing, the world will talk of you yet.

In 1827, Humboldt was called to, and finally settled at, Berlin, with the title of privy councillor and many more substantial honours, which he continued to enjoy till the time of his death, that is, during the reigns of the late king of Prussia, Frederick William III., and his successor, Frederick William IV. A friend to almost every successive administration, he was enabled often to tender the ministry good advice, which was more graciously received from him than from any one. Science is of no party; its politics are universal, since it only can desire the good of mankind. For two years Humboldt tarried in peace in his native town, when he was called by a great potentate once more into the fields of science.

THE JOURNEY TO ASIA.

Hard work in the fields of knowledge never kills any one. Only the weakly and the desultory fall victims to mental exertion. With Humboldt it was far otherwise. At sixty he was as vigorous as ever, and in the year 1829, when he had reached that age, he undertook a most hazardous expedition in Central Asia, in company with two of his friends, Ehrenberg and Gustave Rose.

This expedition, suggested by and carried out under the auspices of the Emperor Nicholas, was directed eastward by Moscow, Kasan, Catherineburg, the Oural Mountains, Tobolsk, and Altai. Thereat the travellers branched out towards the military posts on the borders of China. Returning to Altai westward, Humboldt and his companions passed the steppes of Ischim, Orenburg, Astrakan, and the Caspian Sea. Thence they returned to Moscow, after having travelled over, in the space of nine months, more than 2300 geographical miles. The result of this was not so brilliant as that of his early labours, but it was very useful. He made Central Asia better known to us. By and through him, the curious extravagances of Marco Polo and the earlier adventurers were corrected, our maps made more perfect, and our knowledge of the mineralogy and climatology of Asia extended. The relation of it was published in Paris in 1843, and in German at Berlin in 1844, under the title of "Central Asia," etc. In 1849 he published a further addition to his Researches, under the heading of *Steppes* and *Deserts*, wherein he completely overthrows the theory which had grown up upon Marco Polo's foundation, of a vast central plateau in Asia, to the north of China. This may be seen at a glance by consulting his admirable "Map of the Chain of Mountains and Volcanoes in Central Asia," drawn out in 1839, and published in 1843.

Of the purely scientific results of this travel much may be said. Humboldt determined many of the most important facts in connection with terrestrial magnetism, finding that in those vast regions the sun had more perceptible magnetic power than further north upon its satellite. To his energy and discoveries are due governmental magnetic establishments in Russia, America, France, Prussia, and England, wherein observations are taken and registers kept, and through which much, if not all, of our knowledge is gained. Professor Dove, of Berlin, has reduced many of these registers, and through them has discovered the laws regulating the distribution of heat over the world's surface.

THE NEW REVOLUTION.

In the midst of these labours, time had gradually whitened the head of the lover of science. Time had wrought wonders also everywhere. People were growing wiser, less estranged, more kindly to each other. Humboldt had lived, when a young man, in the midst of the excitement of one French revolution. He saw in it the result of carelessness, cruelty, and luxury on the part of the nobles; and of ignorance, neglect, and starvation in the body of the people. He welcomed it as the forerunner of a better age, but found it spend its angry course in blood, sound, and fury. He had watched each actor tread his part upon the stage and then disappear, and the great actor of all fall, at Waterloo, from that bad eminence to which by cunning and blood he had raised himself. This was during his American expedition and his earlier life. Not to be behindhand, France in 1830, when he was sixty-one years of age, and had just completed his Asian journeys, prepared another revolution, which quietly settled down in the election of Louis Philippe, the citizen king.

It was a delicate flattery towards the *savant's* political learning, that to this monarch Humboldt was accredited by Frederick William III. to acknowledge his government,

and to congratulate him on account of his accession to the throne.

Since that period he each year, until the time of his death, renewed his visits to Paris, greatly to the satisfaction of his very many admirers and friends there, and about this period (1835-38) he published his "Critical Examination of the Geography of the New World."

HUMBOLDT IN ENGLAND.

Allied as we are with Prussia, with almost the certainty of an heir of English descent one day filling the throne, it is some satisfaction to record that, in addition to diplomatists and warriors, she sent us in the train of her ambassadors at least one genius. In 1841 he came, in company with Frederick William IV., to London, and was present at the christening of the Prince of Wales, the Prussian monarch being the royal sponsor. He was received with enthusiasm, and fêted all over the country. With the exception of a flying visit to Copenhagen in 1845, this was, we believe, the last journey undertaken by the great traveller.

THE LAST GREAT WORK, THE "COSMOS."

The evening of life had come—slowly, indeed, but surely—upon him. Calmly philosophical and happy, with a mind full of shadowy pictures of the beauties of the natural world, with a still greater love for God's earth, a still fonder appreciation of its wonders, when he might momently be called to quit it for ever, the wise and good old man determined to undertake a colossal enterprise; one fit, we might suppose, rather for the fire and energy of youth, than for the flagging hand and pausing brain of old age. But Humboldt was one of those perpetual workers who must work or not exist, to whom alone the grave brings rest when it reduces the quick hand to stillness and the busy brain to dust. He thought with Dryden,

> "——— A setting sun
> Should leave a track of glory in the skies."

And the track of glory which he left is his monumental work, the "Cosmos."

In his "Pictures of Nature" (*Anischten de Natur*), he had from time to time culled choice experiences from his voyages; in the "Cosmos" he determined to pass in review the whole sum and substance of what we human creatures know of heaven and earth—that is, of physical, not of spiritual, knowledge. He has attempted the seemingly contradictory task of being scientific and picturesque—hard, dry, and full of details, and yet light, amusing, and instructive. He has wedded the exactness of a carpenter's rule to the glowing description of the pen of a poet, and in this he has generally succeeded. By his "Cosmos" he is more universally known than by any other book. He himself has told us that he regards it "as a work offered to the German public, in the evening of an active life, the plan of which had been present in his mind, in faint outline, for more than half a century."

It is impossible for us here to give a description of the work. The time it took in publication will show its vastness. The first volume of the German edition appeared in April, 1845, and the fourth, thirteen years afterwards, in 1858. A translation by several scientific gentlemen, amongst whom General Sabine may be mentioned, of the first two parts, has appeared in London. The whole work has not, we believe, been translated, or at least published. Tne "Cosmos" is the one work of the great man which will carry him down to posterity; it is the Iliad of this modern Homer, the old man eloquent as the poet, but happily not blind; the Æneid of the new Virgil. "Who else," cries one of his critics, "could have achieved, who but he could have attempted, the Atlantean service? Spread his 'Cosmos' before a young and ardent mind, which has just accomplished its liberal nur-

ture, and say, 'Read and comprehend;' the comprehension exacted will, when acquitted, have added an education."

Thus he grew, flourished, and culminated, full of honours, bearing them meekly as he should do; the friend of kings, nor less so of the humblest scholar.

HUMBOLDT AT HOME.

Three years ago, one* who knew him well described him thus:—He is the observed of all observers, as well known in Berlin as the "Unter den Linden." In spite of his eighty-seven years, he works unweariedly in those hours which are not occupied by the court. He is active and punctual in his immense correspondence, and answers every letter of the humblest scholar with the most amicable affability. The inhabitants of Berlin and Potsdam all know the great man personally, and show him as much honour as they do the king. With a slow but firm step and a thoughtful head, whose features are benevolent, bent rather forward, he has a dignified expression of noble calmness, and bends down to, or responds to the salutations of the passers-by, with kindness and without pride. He wears a very simple dress; and frequently holding a pamphlet in his hand, he wanders through the streets of Berlin or Potsdam unattended, and unostentatiously, a noble semblance of a head of wheat bending beneath the load of its precious and golden ears. Wherever he appears he is received by tokens of universal respect; the passengers step aside so as not to disturb his thoughts, even the very lowest looks respectfully after him, and says to his neighbour, "There goes Humboldt."

THE LAST WORDS OF GREAT MEN—HUMBOLDT'S LAST WORDS.

Time came at last when the philosopher was to return to earth, to cease from the contemplation of God's world here, and to open his eyes upon the heaven of that Almighty Workman, whose wondrous doings he described so enthusiastically and had so ardently loved. Yes, Humboldt was to say his last words—words which all men, great and little, have to say. The whole of life is to be summed up in one moment; and out of the fullness of the heart then the mouth speaketh. Strange have been those disjointed sentences of dying schoolmen, warriors, philosophers, or kings. Strange, too, and yet not to be utterly unaccounted for, the fondness which we have for death-bed scenes and last words. Last words, and more last words! *Eh bien!* What do they teach? We try to snatch from them some meaning, we question these moribund sentences as if they could teach us something more than we know of the world which is to come. We fancy that as Moses from the mountain took that Pisgah-view of the promised land, so from the summit of the deathbed others shall see something of a brighter land still. But though—

> "Examples preach to the eye; care then, mine says,
> Not how you *end*, but how you *spend* your days."

This life-ending is full of intense interest. It will be worth while recording some of these mortuary sayings, for from them one may judge men well. Harry Marten, the great republican, as his last words, wrote the couplet above. Washington told his doctor, "I am dying, I have been dying a long time; but I am not afraid to die." Dr. Johnson's dying adjuration was, "Live well." Scott repeated the advice to his son-in-law, "I have but a minute to speak to you, my dear; be a good man, be virtuous, be religious, nothing else can give you comfort when you come to lie here." Nelson said to Hardy, "Thank God, I have done my duty! I have done my duty!" Sir Harry Vane blessed the Lord, that he (Sir Harry) never deserted the righteous cause for which he that day suffered. Hampden, shot through the spine, and in great pain, yet prayed to God, "Oh,

* Professor Klencke.

spare my bleeding country. Have these realms in thy special keeping. Confound and level in the dust all those who would rob the people of their just rights and lawful prerogatives." Cranmer held his hand into the fire, the hand which had signed his recantation. "This hand," said he, "hath offended, this unworthy right hand." When Raleigh died, he spoke as nobly as he had lived. Running his finger along the edge of the axe, he said, "This is a sharp medicine, but it will cure all diseases;" and he told his executioner when he altered the position of his head, "So the heart be right, man, no matter which way the head lies." Napoleon, acting in his death over again the scenes of his life, mutters as his last words, "Tête d'armée."* Wolsey, whose tortuous church policy had raised him to be the chief man, under the king, throughout broad England, mourned that he had not served God as well as he had served his king, for then, indeed, "he would not have been deserted." Goethe, who had endeavoured to know all that was knowable, cried out, as death's shadow hovered over him, for "Light, more light." And Newton, the great discoverer of the laws which regulate our sphere, the first who could clearly read the system of the Maker, said, meekly, "I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in finding now and then a smoother pebble than ordinary, whilst the great ocean of truth lay all undiscovered before me."

Characteristic all these. Curious also is it, as regards Humboldt, that Jean Jacques Rousseau should have anticipated him in his death words. Jean Jacques, who loved nature as intensely as any one, although his brain had been turned by "vain philosophy," lay dying on a fine evening; there was a sunset glow in the sky, which, as Sidney Smith would say, "glorified the room," and Jean Jacques breathed his last aspirations thus—"How pure and beautiful is the sky. There is not a cloud. I trust the Almighty will receive me *there*."

* Some historians write, "Tête * * * Armée." The difference is essential.

It is on the 5th of May, in this present year of grace, and at three in the afternoon, that Humboldt lies dying; the sun shines brilliantly into the room, and the departing philosopher thus addressed his niece:—"Wie herrlich diese strahlen; sie scheinen die Erde zum Himmel zu rufen!" "How glorious are these rays, they seem to call the Earth to Heaven!"*

When he was committed to the grave Berlin presented a scene that will be ever memorable to those who witnessed it. Early in the morning the people assembled in countless crowds in the Unter den Linden, and in Friedrich-strasse, through which the procession was to pass. Oranienburger-strasse, at No. 67, in which street Humboldt died, was closed to the populace, and nearly all the houses in it were draped with black flags and other insignia of mourning. Those who were about to take part in the *cortége* assembled by degrees before the house, and soon the greater part of the *literati* and known men of Berlin assembled, when those who had not seen the great philosopher since his death hastened to take a last look at his remains. The coffin consisted of a single shell of oak, and was placed in Humboldt's study. Leaves of palm-trees and blooming exotics surrounded his portrait by Hildebrandt, the emblems reminding the spectator of the long and dangerous travels in tropical lands which Humboldt had accomplished.

All his friends having taken a last lingering look at the body, it was conveyed to the catafalque in front of the house, and as soon as the coffin appeared in sight all of the immense crowd who were able to obtain a sight of it instantly uncovered in token of the

* That is, to link the Mortal with the Immortal.

respect they entertained for their great countryman.

The cavalcade was soon afterwards in motion, and after the chief mourners, among whom were his servants and those of his family, followed the students of the Frederick-William University, about six hundred in number, led by marshals bearing black rods; next came a band of musicians, and after them eight clergymen. Before the Frederick Gymnasium in Friedrich-strasse the pupils were assembled, as were also those of another school in the same street, and as the procession approached, the boys sang a hymn, "Es ist bestimmt in Gottes Rath."* Throughout the whole line of procession the crowd took off their hats, and at the windows of the houses, which were filled by the residents, many other marks of respect were observed among the populace, who filled every nook and corner whence a view of the *cortége* could be obtained, and unbroken and mournful silence prevailed. As soon as the Linden was passed, the sound of the tolling bells came upon the ear, mingled with the strains of a hymn sung by the Choral Society of Berlin:—"In Arm der Liebe ruht sich gut."† Under the portico of the cathedral, the goal of the procession, were the Prince Regent, the Prince Frederick William, Prince Albrecht, the young Prince Albrecht, and Princes Frederick, George, Adalbert, and Augustus of Wurtemberg, and Frederick of Hesse Cassel, who received the remains of the illustrious deceased with uncovered heads.

The altar was richly decorated with palms and blooming flowers, and there were four immense candelabra bearing wax tapers, the light from which mingled itself with that of the sun, which had broken bright and clear through the morning fog, and at that moment lit up the vaulted arches of the sacred edifice.

* It is decreed by will of God.

† In the arms of love, how sweet to rest.

The Princes and Princesses Frederick Wilhelm, Carl, Frederick Carl, and Frederick of Hesse, witnessed the mournful ceremony in the church. A funeral sermon was preached by the general superintendent of the clergy, M. Hoffman, after which the assembly sang a hymn, "Jesus, meine Zuversicht,"* a prayer was offered up, then the usual service for the dead was proceeded with, and a hymn by the congregation closed the ceremony.

The coffin rested in the church during the day, but at night it was removed to Tegel, a village near Berlin, were Humboldt's early days were passed, and there entombed. There rest the remains of Humboldt's brother William, who preceded him to the tomb twenty-four years ago, and the place is further distinguished as containing a beautiful statue of "Hope," by Thorwaldsen.

So ended the life-long labour of Love. A sweet life this. Not dedicated to selfish aims or sordid gains; not to tortuous policy or diplomatic lie; not like that of one called away but a few weeks after him, Prince Metternich, of equally widely extended fame. God approving the simple and earnest life, made it long beyond that of others, and calm and untroubled, like sweet music, to its close. Now, whilst the noise of drums and trumpets, of march and countermarch, of victory or defeat, fill the post-horns of all Europe, it is good to look upon it. When we see around us men struggling for sordid gold, it is sweet to look again on one who thought the earth and sea and sky somewhat richer than a banker's book. At all times it is pleasant to ponder on such a life, and to remember, whilst we do, that

"——Only the actions of the just
Smell sweet and blossom in the dust."

HAIN FRISWELL.

* Jesus, my final hope. Zuversicht—Providence or trust.

—o—

TALK ABOUT TREES.

There is no wood that does not contain a variety of trees which, however they vary in character, belong, according to naturalists, to two great families, known as *endogens* and *exogens*. To the former belong those graceful and gigantic denizens of the tropics which we are more familiar with in paintings than in person; where the bamboo and fan-palm rear their polished stems and broad-leaved foliage to the skies. These trees are not considered to possess a true bark, but in some kinds the cuticle, or outer covering, is composed to a great extent of *silex*, or flint, so much so in some kinds of cane as to emit sparks, if struck with steel, and forming a beautiful object under the microscope. Endogens are hollow in the middle, or, as in the case of sugar-cane, made up of a succession of tubes; but, nevertheless, although not capable of being used for the ordinary purposes of wood or timber, they are eminently adapted for purposes which are conducive to the comfort and convenience of the inhabitants of those regions where they are found. It is only necessary to take a glimpse at the mechanical products of the Indian Archipelago, to illustrate this. We have only to remember the beautiful baskets and fans which are formed, not only of the bodies and branches of these trees, but of their leaves, which are tougher and less perishable than those of our own country. Nay, we may go further, and refer to the houses which are built entirely of bamboo, and in South America are very much like immense bird-cages. These species of trees are composed of filaments, readily divisible, but the surface as a whole, longitudinally, is extremely hard and polished. The palm best known to us is the cocoa-palm, which grows to a vast height without a single branch, and has a head of leaves, amidst which the cocoa-nut, so familiar to us, grows. This, whilst it is green, and might be injured, is defended by a shell of great thickness, composed of filaments of somewhat the same character as the wood itself, or rather the cuticle. Of late years a most important article has been introduced into this country in the shape of matting made from this fibre, and twisted into ropes; it is durable and cleanly, inasmuch as its rough surface readily allows of being cleansed from dust, etc. Those who have visited the bamboo forests of India have seen a beautiful, if not a sublime sight. Imagine a forest of polished columns of Nature's own making, branching out at obtuse angles upward in every direction, and terminating in silken tufts of foliage, glancing to the sun with every zephyr that blows. As one universal link is kept up in all Nature, these wondrous natural structures are but vast examples of the silken grass stems that are crushed beneath our feet as we wander in the summer meadows: erect these (in thought) into a thousand times the size, and diminish yourself to a fly's bulk, and you have the Indian scene before you. Among the endogens we have some of those specimens of endurability which seem almost indestructible by time and the rigour of climate. Thus, the *Dracæna draco*, found in Teneriffe, was but a few years since, if it be not now, alive, being computed to have been in existence in the fourteenth century—this is really a splendid species. The mode in which endogenous trees grow may be illustrated by supposing that a bundle of straight fibres were placed side by side around a circular pole, that they were tied in at the lower end, the pole then withdrawn, and that they retained their position, they would appear, as in the accompanying figure. And thus in reality they grow, concentring at the root, and often terminating at the *apex*, in the

endogens, in a single bud. Various opinions have been formed as to the mode in which these fibres were originally formed, some botanists contending that each filament,

or each bundle of fibres, is, in fact, a *root of a leaf*, and this is strengthened by the fact that in the endogens the fibres forming the leaf lie side by side in parallel lines. The leaves of this family of plants are sometimes of great size, extending to as much as forty feet in width—enough to cover a dinner-table with an extempore green cloth! Endogens contain a great proportion of trees yielding fruit applicable for food, and, perhaps, fewer poisonous plants than the exogens, and there is a remarkable contrast in size in some specimens. When we come to consider the exogens, we find amongst them all those trees which we may truly call "timber," and which are found in such numbers and varieties in Old England, not to mention others which have been found capable of existing in an English climate. In this class we have what may be truly called "wood," and defined as that portion of the tree existing between the pith and the bark. Botanists regard this substance as bundles of woody tissue or fibre, but, taking a timber tree as a whole, it is divided as follows:—The centre, pith; next to that, heart-wood; then sap-wood; then bark. The pith is a cellular substance, large in comparison to the size of the plant when very young; this comparison, however, is soon lost as the young plant becomes a tree, and in old age is nearly indiscernable. Linnæus—that father of naturalists, whose works, imperfect as they are, having relation to modern discovery, will long stand unrivalled—amongst other theories, considered that the pith held the same place in trees that marrow does in the human frame, and was, in fact, the centre and soul of the life; this, however, was never, I believe, followed, because it was untenable; and, therefore, at the present day, pith may be defined as a cellular substance found in the centre of the bole and branches of a tree, but not of the roots (that is, of exogens). When young it is filled with fluid and grains of starch, which disappear when the foliage becomes organized, and so serves as a magazine for nutriment. The supposition is, that at this period its office is performed, that it then dies, and, gradually contracting in bulk, at length entirely vanishes. There is no doubt, however, that a communication is kept up between the centre and circumference of timber-trees, as the rays which radiate to the bark seem to prove. These are called medullary, or marrow-like (founded, perhaps, on the fact that they communicate with the centre), and these again communicate with the leaves by cords of a fibro-vascular tissue. The heart-wood, which is resident next to the pith, forms, towards the centre, the true timber, and the support of the tree by its firmness and solidity. This increases in density and hardness as years pass away, partly, no doubt, by age, and partly by accumulated pressure from without. Heart-wood may be regarded as comparatively a dead substance, although it cannot be denied that it always contains some moisture or juices, but these are not in active circulation. Whilst the tree is a growing tree, the mode in which it is formed is by a constant annual deposit and outward growth, by which layer upon layer being added, the tree gradually increases in bulk, and those rings are formed which we see at the end of a fresh-cut stick of timber. External to the heart-wood is the sap-wood, or *alburnum*, which may be regarded as the heart-wood in a young or progressive state. The circles seen in the heart-wood are known as *spurious grain*, and are in fact nothing more than the junction of the annual deposits. The medullary rays are also known as *silver grain*. The sap-wood,

or *alburnum*, with the bark, is in truth the growing part of the tree, which, being constantly deposited from the bark and inner bark, becomes in its turn converted into wood or timber.

Spring gives a new impulse to vegetable life, and the living juices of trees, no less than the current in our own veins, feel the influence of the genial ray. The absence of that amount of moisture in the upper part of trees which occurs in winter, causes the cellular tissues to become, as it were, *vacua*, and the sap rises by what is called capillary attraction.

Of the specific gravity of woody fibre, water forms usually two-thirds; but woods differ extremely in this particular as well as in their contractile power, which depends entirely upon the direction of the fibres. The lighter the wood, the greater capacity it has for imbibing moisture, and some trees secrete a vast amount, either of watery sap, as in the *Betula alba*, or white birch, or gum, as in the caoutchouc (*Siphonia elastica*); others, such as Brazil-wood, log-wood, etc., have very useful qualities for staining by the juices that they secrete. Others, such as mahogany (*Swietenia mahogani*), rose-wood, which is produced by a species of *Mimosa*, king-wood, etc., are coloured by these juices, and are used in ornamental work. Satinwood (*Chloroxylon Swietenia*) is well known, and yields a wood-oil, as also does the sandal-wood (*Sandonicum*) of the family *Meliaceæ*; ebony (*Ebenaceæ*) and calamander-wood (of Ceylon) are examples of this kind. With the characters of the fir tribe we are well acquainted, it being a matter of notoriety that they yield all the resins, and that tar is made from their roots.

With regard to the rising and falling of the sap, a familiar illustration has often been given in proof of the alleged fact, that there is a much greater quantity of sap in the upper than in the lower part of a tree; namely, that if a piece of the bark is cut out transversely in spring, the sap exudes in much greater quantity from the upper part than from the lower. This is owing to the fact that the sap current is upward in the wood and downward in the bark.

The last portion of the tree to be considered is the bark. This substance, which varies from a mere thin skin to a coating a foot in thickness, as in the case of the Douglas Fir of America, is composed of several parts. The innermost (we have been proceeding *from* the centre) is called the *liber*, and a soft viscid substance, called *cambium*, or *parenchyma*, which form what are called the *cortical layers*, or layers of the bark. Through this substance the ligneous cords and medullary processes pass, and it is perforated by cellular tissue; wood being, in fact, a collection of tubular and vascular tissue. Outermost of all is the true bark, the *epidermis*, or cuticle, through which the atmosphere acts on the plant; not referring to the leaves, which forms matter for separate consideration. The bark is, in fact, an organization to inspire and expire by, but whether the wood is formed by or from the leaves is a vexed question. The leaves of exogens ramify from a centre or midrib, and are netted in the most exquisite manner; whereas those of endogens, as I have before observed, grow in parallel lines. Endogens are so called because there is a continual development towards the interior, and we find them spoken of by Theophrastus. Several elaborate works have been published on this class, to which the grasses belong. Endogens sometimes terminate in a single shoot, whereas exogens are furnished with buds which are axillary, or resembling arteries from the main vein. When the spring-growth in trees takes place, there is a spontaneous separation between the liber and the bark, which is necessary for the growth of the wood; an addition to the wood is taken from the liber, and the cortical layers again receive an external addition, and so the tree progresses.

The embryo tree is indeed a wonderful object, and well worth examination; but it is not until the second year of its life that woody fibre begins to be deposited; before that period it is a mass of cellular tissue only, pierced longitudinally with woody matter; when, however, the future tree is once actually and regularly formed, all goes on in the same routine to its fall by the hand of man or the decay of nature.

The bark is continually renewing internally as it externally perishes, and seems to form a protection and a vehicle as circumstances of situation and climate require. Thus cork, that useful and well-known substance, is the product and covering of a species of oak (*Quercus suber*), grown chiefly in Spain. As to the uses of wood, the formation and situation of the tubes or cells, the form of the cotyledons or seed-leaves, or the botanical arrangement, I shall now say nothing; suffice it that the exogens are the more numerous, and are found in all countries, and number nearly 60,000 species, that is, of exogens generally, including trees; the ordering of which is not considered by any means satisfactory. Some of the noblest specimens of timber of which this island can boast are of the cedar (*cedrus*) or fir (*pinus*) kind; and the silver-fir (genus *Picea*) has attained in some instances a vast growth. But what are these compared to the cotton-trees of California, the boabab, or monkey-bread tree (*Adamsonia digitata*) of Africa, which is of this tribe (*Bombaceæ*), being said to be the largest tree in the world, giving a bulk of 60 feet in circumference to 12 in height! If travellers can be credited, when one of the Californian trees has fallen from old age or some other cause, the way is completely blocked up by its prone stem, which rises in diameter to the height of a man on horseback! A hollow cotton-tree has formed the shelter for a party of horsemen from the *El norte*, or sudden hurricane of the South American continent, and a habitation during a whole winter for a squatter and his family; and they frequently reach the enormous height of 350 feet!

O. S. Round.

WARDIAN CASES.

It is too often the case that those who intend to embellish their dwellings with fern-cases defer the planting of them till the season of flowers is fully over. The cases are then placed in the windows, and planted with ferns, but owing to the rapid decline of the season, there is not sufficient warmth to enable the plants to make fresh roots in their new abodes; and besides this, having completed their season, and formed the hidden fronds which are to appear next spring, they have but little disposition to send out fibres into the soil to which they are thus untimely introduced. Hence, where such adornments are used only in the winter they should be planted at once, while vegetation is still active, in order that they may be, to use a horticultural phrase, "established" before winter sets in. Evergreen ferns should be chosen for the purpose, and unless the cultivator has had some experience, the hardiest British and exotic ferns should have preference over kinds that are tenderly constituted. A very simple way of stocking fern-cases which are to take the place of flower-stands and other summer embellishments, and which are to be removed in the spring, is to procure an assortment of healthy plants in small pots, arrange them to produce a good effect, and then hide the pots by a covering of fresh moss, which will keep its green colour till spring. Cinders are the best drainage for fern-cases, and turfy peat the best soil.

H.

COLLECTING AND PRESERVING FUNGI.

COLLECTING FOR THE TABLE.

First procure an oblong flat-bottomed wicker basket, about from four to six inches deep, but with no lid, such as is commonly used by butter salesmen in country markets. Have a clean cloth large enough to line the whole of the basket, and form two folds over the top. Also procure a sharp knife and a house-painter's brush. Select dry weather, if possible, and go out as early in the morning as you can conveniently. When you reach your collecting-ground avoid most carefully all fungi that have been broken by cattle or other causes, also all which from their shrivelled appearance, change of colour, or otherwise, indicate they have passed their prime,

BASKET.

selecting only those which are still attached to the earth or other substances, and are still living and in a growing state; collect each separately; first clean away with the brush all dirt, dust, grass, or foreign substances, especially flies; next, cut off the root a good inch from the extremity, and throw away with it the attached mould. You will now readily see, by the porousness of the stems, which are attacked by maggots. Such will always be the oldest, and had better be kept in a corner of the basket by themselves. The cloth should be constantly kept covered over the fungi, both while collecting and returning home, to prevent the attack of flies, etc., which are always on the look-out; in fact, where they are in any abundance it is well to collect and prepare them in heaps on the ground and put them all in the basket at once, as by constantly opening you may truly shut in instead of out many of your greatest enemies.

The above directions will stand good for most of the agarics, helvellas, morells, boleti, lycoperdons, etc.; there are a few exceptions, however, as Agaricus atramentarious and cornatus, which are of such a juicy or deliquescent nature that in a few hours or less a large portion of the fungus turns to liquid, and would make a miserable mess and confusion in a basket with other species. They should, therefore, be collected in a large pie-dish or some other earthen vessel.

The truffle will require a very different process in collecting, the task being generally left to dogs trained for the purpose, and known as truffle-dogs. The truffle-hunters in Hampshire (where they are rather common on the chalk, and especially under beech-trees) are furnished with a stout ash stick, about the size of an ordinary broom-handle, and tapered at one end to a rather stout, blunt point; this point, for about three inches, is iron, in the form of an extinguisher, and firmly fitted on the wood. With this, when the dogs have indicated the whereabouts by scratching, the collector grubs them up. As they are of a solid nature, and in form and size somewhat resembling potatoes, of a dark colour, with an irregular, warty surface, they may be collected in a bag, basket, or whatever is most convenient. Having now collected and conveyed home our specimens, our next aim is either to preserve or prepare them for the table. Of course, I now allude to the thirty species which, with proper treatment, are known to be wholesome, and which are natives of our land and comparatively common.

SALTING AND PICKLING.

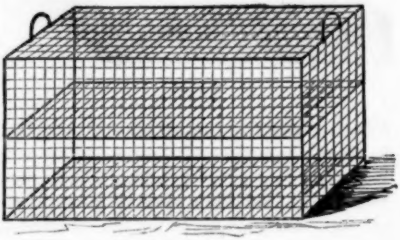
They may be preserved in a variety of ways for the table, the most usual being dried in the open air, strung on strings, or preserved in oil, vinegar, or brine. Agaricus procerus, Boletus edulis, and Tuber ciberium may be even preferred raw; while others, as the helvellas, having somewhat the consistence of leather, are decidedly improved by cooking. There can be little doubt we have poisonous species, as Boletus luridus, Agaricus muscarious, etc., care should, therefore, be taken in collecting, and all brine, vinegar, or oil in which they have been preserved should be thrown away, as it is supposed that the poison is extracted by the liquor in which they have been preserved, while the fungus, even in poisonous species, becomes a wholesome food.

PRESERVATION OF FUNGI IN LIQUIDS.

The higher orders of fungi rarely appear in the herbarium, from the erroneous impression that it is impossible to dry them. It is quite true that many are of so delicate, fragile, and watery a nature, that it is quite impossible to dry and press them; for these there is but one simple process, that of immersing them in bottles of a solution prepared for that purpose. There are many of these solutions in use for botanical, zoological, and anatomical purposes, but only one or two, I find, can be even moderately depended upon. Most spirits defy nearly all efforts to prevent evaporation, and they extract and destroy the colour of the plants, by which they lose their transparency. On the other hand, most solutions, from a combination of chemical salts, become opaque, and form a crystalline deposit round the mouth of the jar, which, from contact with the air, gradually feeds upon the covering of the vessel; nor are acids always to be depended upon, extracting the colour and more or less destroying the most delicate and deliquescent species, especially if exposed to agitation. Where expense is not studied, one evil is, to a certain extent, remedied by throwing away the solution in which they have been preserved for about a month, and which by that time has extracted the colour, then replace it with fresh, and there is not that danger of the liquid being discoloured. A few will be found of such a solid and dry nature as to require no drying, and must be kept in a cabinet, or drawers, as they will not flatten by pressure. We now come to a large bulk of the higher orders, which, although it is not absolutely necessary to keep them in solution, it is looked upon as a laborious and difficult task to dry and press them, and when done, the sections, etc., usually taken are but a humble apology for the whole plant. For these I can recommend the following methods as far superior to those in general use:—

DRYING FUNGI FOR THE HERBARIUM.

Procure a wire cage, such as is used by rat-catchers, about twenty-four inches long,



WIRE CAGE.

twelve wide, and twelve deep, with a shelf of the same material in the centre, or of smaller dimensions, according to the requirements of the collector. Let the wire be sufficiently close to keep out the ordinary flies, but no smaller, as we require a free ventilation; should the flies still get in, cover with a net sufficiently fine to exclude intruders. Arrange the fungi in rows

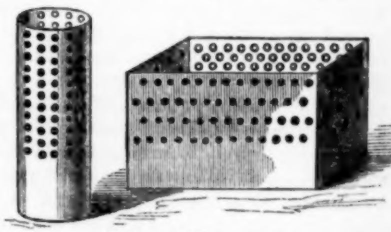
with stems downwards, resting on strings crossing from side to side, and each free from its neighbour. Let this cage be suspended in the air if possible, as from a clothes' line, and in a draughty situation, as a passage between two houses; a cool, shady spot being preferable, as it is the air, and not heat, which we wish to dry them. The surface of the fungi may be also pricked freely with a darning needle. As soon as they commence shrivelling, or show symptoms of drying, remove them from the cage, bend down the stalk in the direction of the pileus, or cap, and gently press them for twelve hours; remove them from the press, and again lay them flat in the cage, and expose them to the air till they appear sufficiently dry to bear further pressure. Again remove them, and lay them between flannel three or four times double; on this put a thin layer of cotton wadding, another layer of flannel, then a fresh layer of fungi, and repeat the layers of flannel and wadding as long as you have specimens. Put them in a box of suitable size, and subject them to pressure by placing a sheet of paper over the whole, and spreading sand lightly over the surface till the whole is covered about an inch and a half deep. Leave them for about two days, then remove them, and press between drying paper, put on perfectly hot, for twelve hours.

DRYING IN SAND AND LIME.

There is another process, not generally known, by which they may be preserved either in their natural form or flattened for the herbarium.

Take the whitest sand, nine pounds, powdered lime, one pound. Mix thoroughly and sift through a fine sieve, let the whole be well dried and kept in an earthen vessel closed against the air and damp, ready for use.

Take tin boxes, of different sizes, perforated freely with holes, large enough to admit a moderate-sized pea, on the top and on all sides, from the top to about two inches from the bottom, but no lower. Next, take some sheets of blotting-paper, drying-paper, or flannel, line the sides of the boxes as low as the holes, but no lower; put a layer of the mixed sand and lime in the box (not heated), then place your fungi stems upwards, gently shake in the mixture till it reaches the edge of the pileus or gills, but not to cover them; now take a few strips carelessly torn from your paper or flannel, sufficiently long to cross the gills of the fungi and touch all sides of your box, like the medullary rays of an exogenous stem. This, by means of capillary attraction, will absorb the moisture from the gills of the fungi as well as that taken up by the sand, and convey it to the paper at



TIN BOXES WITH HOLES.

the sides, where it will evaporate through the holes and escape into the atmosphere; the box should be filled with the mixture to within half an inch of the top, but do not cover the top with paper. When all the boxes are prepared let them be stood in a *slow* oven, on the hob of a fireplace, the funnel of a steamer, the boiler of an engine, bath-room, or any situation where there is a regular and not too high a temperature. Take especial care that the temperature is not excessive, and that the sand is *not* put in hot. I have little faith in drying by pouring heated sand upon them. It is not a sudden and high temperature we require, but a low continuous heat, and that from beneath, driving the moisture to the surface, where it will evaporate. To ascer-

tain if they are sufficiently dry hold a piece of clean dry glass over a perforated box at a tolerably high temperature. If moisture is still remaining it will soon be indicated by a foggy appearance on the glass. With respect to flattening, as fungi are generally of a tough leathery texture, they may be flattened with care in an ordinary press, and I believe that their form, like that of most cryptogamic plants, may be restored by boiling water. Specimens to be collected for the herbarium should not have the roots cut off.

FUNGI ON THE STEMS OF TREES.

The parasitic and epiphytal fungi demand but few words. They are mostly on leaves of plants, and will simply require to be collected between the leaves of a folio book, and pressed by means of a string tightly bound round it. Many on the bark of trees, stems of plants, decayed wood, etc., may simply be shaved off by a chisel or sharp stiff knife, and dried in a warm room, or in the sun, and pressed if inclined to shrivel. Those found in or on the surface of liquids will require a very different treatment; when first removed from the liquid they must be placed on a pad of blotting-paper, six or eight sheets thick, and laid on a sloping board to drain, and during intervals as much must be absorbed as possible by gently pressing blotting-paper on the surface. No attempt should be made to press them till as much moisture as possible is absorbed by exposure to the air, and take especial care to keep them in a moderately cool temperature till the liquid appears absorbed; they should then, if possible, be placed on the paper intended for mounting, and paper and specimens together put between folded sheets of blotting-paper, and pressed very tenderly, and with care not to rub off the bloom. If very delicate, or of an irregular surface, they ought not to be pressed, but dried by the air, and protected on the herbarium paper by a light wooden frame surrounding them. Those that are found on bread, cheese, potatoes, and other decomposing provisions, should be dried by exposure to the air, and mounted for the herbarium in white card-board boxes with glass lids; many of the extremely delicate must at once be mounted between glass for the microscope, being the only way to preserve them. Many of the agarics and other fungi may have their delicate colours preserved by absorbing any moisture on their surface with a piece of blotting-paper, and varnishing them with a hard transparent varnish immediately they are removed from the ground, or wherever they grow, and suspended with strings in the air. Where the whole plant is coloured, and several are collected, different parts of each should be varnished, as the moisture cannot evaporate through the varnish.

PRESERVING THEM WHEN MOUNTED.

Fungi are so delightful a relish to insects, that they will soon be devoured if not poisoned. Camphor so soon evaporates as to became a most expensive, troublesome, and, some say, most inefficient remedy, and its perfume becomes deleterious where in constant use, producing headache, etc., when confined in a room without ventilation. Turpentine and other essential oils become most obnoxious in glass cabinets, their resinous and greasy consistency encouraging the accumulation of dust on the specimens, the glass becomes dull and greasy, and, even if suspended in phials, are liable to be upset, and cause sad havoc in a collection neatly mounted. A solution formed of spirits of wine, corrosive sublimate, and a very small proportion of camphor, is most generally efficacious; but the use of this will vary almost as much as the plants vary themselves. In the leaf fungi the camphor must be omitted, as it forms a crystalline deposit. For many of the agarics water must be added, or the mixture will destroy the colour. With the more delicate a coat of varnish answers admirably, as it at the same time fixes

them to the paper, and prevents their being rubbed off.

I use three ounces of corrosive sublimate at the time (sufficient to poison a little multitude), and have always several preparations in hand; but I should advise amateurs not to manufacture for themselves, as poisons are dangerous tools to play with.

MOUNTING.

The larger species must be glued on paper the size of the herbarium. For this purpose the best transparent glue must be obtained, broken and soaked in cold water two days before using. There can be no rule with such an extensive and variable order as this, but in some cases oil, in others mutton fat, and in others lime-water must be mixed with the glue. For the smaller a solution of gum acacia should be used, with a little whiting and moist sugar, and four drops to the pint of oil of cinnamon. The most delicate may be floated on paper from gum-water, and when dry by exposure to the air, lightly coated with varnish; the same process as used for seaweeds will be useful for many fungi. Leaf fungi will form good practice and good objects for drawing or tracing, mounted between two sheets of glass; the smaller species should be mounted on small pieces of paper, and pinned on the herbarium paper, they can then be removed from time to time, as others are added. Both sides of the fungus should be shown when possible.

FREDERICK Y. BROCAS.

DIATOMS:

HOW TO EXAMINE AND PREPARE FOR THE MICROSCOPE.

HAVING obtained, as supposed in our last, the materials for examination in a satisfactory condition for working with, let a little of the brown jelly-like substance be taken up on the point of a pen-knife, and placed on a slip of glass, three inches by one, called a slide; over this put a piece of thin covering-glass, and, if necessary, add a drop or two of the water from which our objects were taken. A *very small* portion will suffice, for the power to be employed makes it seem two or three hundred times as much as it really is. In such an examination as this, use for the ordinary slide a larger one, with a slip cemented at the bottom, called a glass "table;" this will prevent water running down on to the frame of the microscope, which would, particularly if it contain salt, quickly injure it.

If now we have got hold of naviculæ or their allies, a very curious sight will be presented, the whole of the objects in the field of view being endowed with active life and moving about in different directions. This motion is well calculated to arrest attention; it is not the rapid meteor-like whirl of most of the infusorial animalcules, but a gentle gliding in one direction, the distance and the time occupied in traversing it being clearly defined and readily noted by a good watch; there is then a brief period of rest, and the return journey is duly proceeded with. Should two meet in their paths, they may either glide past one another, or, after being stopped in their forward course for an interval, they will set off back again; so also if it be a fragment of stone by which they are arrested. That the force with which they move is considerable will be readily seen by the vigorous way in which bits of stone, etc., will be pushed aside. Calculations of the rate of speed in different species have been made, to the effect that the most rapid will

get over a space equal to an inch in about three minutes, and the slowest in about an hour; but such convey a very erroneous impression, since the minute size of the objects is left out of the account, and the above distances should be multiplied by three or four hundred to obtain a true idea of the rate of speed as seen with the microscope. The reasons for, and way in which, these motions are effected are involved in some obscurity. The most probable supposition is that they are connected with vital processes, the formation of oxygen, and growth of the minute organism. That there are external organs for producing it has been asserted, and lately revived, but the most careful and trustworthy observers agree that with the best glasses they have never seen any such; and the very delicate mycelioid filaments with which some species especially are liable to be infested have no motion, and can therefore have nothing to do with it. Frustules detached from filaments or their stalks, where they have such, will occasionally move, but in a more languid and irregular way than those which live free.

To ascertain readily the exact characters of a Diatom which may appear new or doubtful, the best way is to put a little on talc, and expose to a gentle red-heat; the peculiarities of shape, the angles, the markings, then come out with great sharpness, and may be studied with ease and satisfaction. The simple way of drying on talc presents advantages for preservation in an herbarium, for interchange with brother (or sister) collectors through the post, and so on.

To mount for the cabinet, however, most will prefer them put up with Canada balsam, on glass slides. Filamentous forms we have seen well and readily prepared by careful heating on a slide, and then covered up. There is so little satisfaction in mounting in fluid, and so much risk of loss, that we do not recommend this mode of preservation. The usual way of obtaining Diatoms in a fit state for mounting, is to put some of the material into a little porcelain or platina cup, to pour nitric acid over it, and then to boil for a short time; what remains should then be carefully washed with pure water several times in succession, in a precipitating glass, allowing the fine white powdery sediment, composed of Diatoms, to fall between each time of washing. Very ingenious ways of obtaining those of different sizes, as large, middling, and small, have been adopted, on the principle of allowing different periods to elapse for the sediment to fall. The advantage of these will be best appreciated in working with fossil, or semi-fossil gatherings. It has been asserted that the acid begins to act upon the Diatoms injuriously after more than a minute or so of boiling, but we have met with only one or two instances, and those somewhat doubtful, where such an effect appeared to have been produced, and, on the other hand, have known them boiled by the half-hour together without any harm resulting. Caustic potash and soda, however, will very rapidly destroy them, and form with them soluble silicates. It would be interesting to ascertain whether ammonia will do the same, and under what circumstances: that it will in certain conditions, appears extremely probable, or what becomes of the beautiful theory by which the formation of flints out of sponges is accounted for?

When the acid has been thoroughly washed away, the Diatomacean sediment may be kept for any length of time in small labelled bottles, with a little pure water; and to mount them, nothing more is required than to shake the bottle, take up a small portion of the milky fluid, put it on a slide, and when quite dry, add Canada balsam, and a thin covering-glass.

It is sometimes advisable, especially when working with new and rich gatherings, to look carefully over a slide before the balsam is hardened; different views of a rare form, such as could hardly otherwise, may thus be obtained, on moving it by gentle pressure on

the covering-glass whilst under observation. Had this simple expedient, which is equally available to examinations in water, been more generally adopted, our knowledge would be more complete than it is of some doubtful forms, whilst others would never have obtained admittance on our lists to become "opprobria Diatomearum"—horrid puzzlers that we know not what to do with. An easy way of hardening the balsam, when the mounting is complete, is to put the slide on the mantel-piece, in a room with a fire, for a few days, or it may be put over a water or sand-bath, on a little metal table heated by a spirit-lamp; or where many have to be done at once, in an ingenious apparatus, like the Dutch-oven in principle, to which the name "Retino-Klibanon," or slide-dryer, has been applied.

TUFFEN WEST.

METEOROLOGY OF SEPTEMBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1842	79.0	42.5	—
1843	78.0	35.0	—
1844	78.0	39.5	2.7
1845	73.0	32.0	1.5
1846	79.5	46.5	1.3
1847	65.0	33.0	2.2
1848	78.0	37.5	3.5
1849	77.7	33.8	5.0
1850	74.4	33.0	2.0
1851	79.0	35.0	1.5
1852	79.0	32.0	5.6
1853	70.2	33.5	2.1
1854	82.1	33.5	0.9
1855	74.9	33.5	0.7
1856	71.6	36.3	2.6
1857	76.5	37.5	3.0
1858	85.0	37.9	2.3

The greatest heat in shade reached 85.0° in 1858, and only 65.0° in 1847, giving a range in greatest heat of 20.0° during the past seventeen years.

The greatest cold was as low as 32.0° in 1845 and 1852, and never below 46.5° in 1846, giving a range of 14.5° in greatest cold.

Three-quarters of an inch of rain is the lowest amount that has fallen in September, this occurred 1855; 5⅝ inches fell in 1852, being a range of 4⅞ inches.

September is usually free from cloud, and at night the temperature descends towards the freezing point

E. J. LOWE.

ASTRONOMICAL OBSERVATIONS FOR SEPTEMBER, 1859.

—o—

Sun in constellation Virgo till the 23d, then in Libra. On the 1st the sun rises in London at 5h. 19m. .m., and sets at 6h. 46m. p.m. On the 30th he rises at 6h. 0m. a.m., and sets at 5h. 40m.

Twilight ends on the 6th at 8h. 38m. p.m., on the 28th at 7h. 38m.

Day breaks 12th, 3h. 20m. a.m., 27th, 3h. 59m. a.m.

Full moon 12th, 8h. 31m. a.m. New, 26th, 1h. 56m. p.m.

The moon at greatest distance from earth on the 8th, at midnight. Least distance on the 24th.

Mercury is somewhat favourably situated for observation, being in Leo at the commencement of the month, and in Virgo at the end of the month.

Mercury in conjunction with Mars; evening of the 6th, within 5° of moon on the evening of the 25th.

Venus very small, and very unfavourably situated for observation. In superior conjunction with sun on the 27th.

Venus in Leo till the middle of the month, then in Virgo.

Mars in Leo. Invisible, close to the sun.

Jupiter in Gemini, a morning star, rising midnight.

Saturn is in Leo, and invisible until the end of the month, and then unfavourably situated for observation.

Uranus is in Taurus.

Occultation of Stars by the Moon: On the 16th, Epsilon Arietis, 4½ magnitude, disappearance, 9h. 55m. p.m.; reappearance, 10h. 10m. p.m. On the 22nd, mu Cancri, 5th magnitude, disappearance, 1h. 29m. a.m.; reappearance, 2h. 21m. a.m.

Eclipses of Jupiter's Satellites: On the 7th, the 3rd moon will disappear at 1h. 29m. 50s. a.m., and reappear at 4h. 25m. 45s. a.m. On the 13th, the 1st satellite will disappear at 1h. 20m. 52s. a.m.

E. J. LOWE.

THINGS OF THE SEASON—SEPTEMBER.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

BIRDS ARRIVING.—Sea Curlew, Snipe and Snipe Jack, Green Sandpiper, Bean Goose.

BIRDS DEPARTING.—Blackcap, Nightingale, White Throat, Sedge Warbler, Reed Warbler, Wood Wren, Grasshopper Lark, Reed Sparrow, Swallow (*H. rustica*), Red-backed Shrike, Flycatcher, Chiff-chaff, Stone Curlew, Wheatear, Ring Ousel, Sandwich Tern, Common Tern, Black Tern, Ruff.

INSECTS.—Twelve and Sixteen-Spotted Ladybird, Clouded Yellow, Convolvulus Hawk-moth, Death's Head Hawk-moth, Helophanus fennicus, Chlenius vestitus, Acridia viridissima.

WILD PLANTS IN FLOWER.—Small Fleabane, Common Ragwort, Creeping Water Plantain, Jointed Glasswort (sea-shore), Saffron Crocus, Grass of Parnassus, Persicaria, Arbutus, Sharp-leaved Mint, Red Mint, Woundwort, Bur Marigold.

Mr. Noteworthy's Corner.

ALLEGED SHAKESPERIAN FORGERIES.—Mr. Collyer discovered, and bought in 1849, a copy of Shakespeare's works printed in 1632, which contained emendations by one Thomas Perkins. The book under any circumstances was a treasure, and Mr. Henry Rodd, the bookseller, must have been very careless to let it slip for a trifle into Mr. Collyer's hands. The latter gentleman kept his treasure some time. Then it gradually oozed out that he had it. In 1853 he published a corrected edition of the works, with these new old readings. In 1856 a complete list of all the readings appeared. Since then there have been floods of papers on the folio of 1632. All the editors and commentators were against "Perkins," whoever he may have been, or be, for he was against all. What with comma, dot, dash, alteration, new word, new line, altered letters, these emendations amounted to thousands; of the more important there are one thousand three hundred and three. Of these only two hundred and ninety are worth much. Of them one hundred and seventy-three have been part of the received text for a quarter of a century, and the remainder one hundred and seventeen have fair claims to be received as really emendations.

Nobody knows who "Perkins" was. Some say a player, others an author; others, one who attended the plays with the folio in his hands, and corrected as he heard, or thought should be. His emendations have no more authority than Stevens's, or Malony's, or yours, or mine. His volume is *bound* in rough calf, about the date of George II., the fly-leaves having a water-mark G. R., crown and Dutch livre—obvious, by the way, William III., Gulielmus Rex., and the Dutch arms, not George II., as Mr. Hamilton will have it—and having been given by Mr. Collyer to the Duke of Devonshire, has by him been placed in the hands of Sir F. Madden, keeper of MSS. of the British Museum, for the inspection of an inquiring public. This year, Mr. N. E. S. A. Hamilton, of the MSS. department, has examined the folio with a microscopic eye, and has written a long letter to the *Times*, asserting that the emendations are forgeries; that beneath the ink letters are others in pencil in "stiff chancery capitals of the present century," in "the modern hand of to-day," with the printer's corrections of the hour, etc., etc.; his inference being that some one made all the corrections with pencil, then had them copied in antique writing. Some of the corrections have been allowed to remain, others have been effaced, either by the knife or chemical agency. The whole gist of Mr. Hamilton's letter being an accusation of an impudent forgery by some person or persons unknown, the forgery being published by Mr. Collyer.

Mr. Collyer has replied to this by a very long letter, in which he re-states all that he has ever asserted. Firstly, in reply "to what is meant, although darkly asserted," that "he is the author of the pencillings and notes in ink," he has, in 1856, declared on oath that he was not, and the affidavit is filed in the Queen's Bench. He has also sworn that the very book, fifty years ago, belonged to one Parry; and had been given to him by a relation, George Gray. There is also this to be said, viz., that had Mr. Collyer wished for fame, he might have appropriated all the emendations, and have burnt the volume. This he did not do; had he done so, he would have had a brighter Shakesperian fame than all the commentators put together; but he adds, "This I did not do, in spite of the warnings of a friend, that my enemies would never forgive my discovery, and that their hostility would outlive my existence." Thus, apathetically, Mr. Payne Collyer, who further states his determination not to waste any more time in answering, but if, need be, again to establish his fair fame by law. The whole correspondence is curious. Mr. Collyer never claimed for his folio more than the value any conjectural emendation should have. He has not stated that the corrections were by any one of authority, yet many of them are so apt that they are irrefragable. Mr. Hamilton's accusations so far fall to the ground; for if the corrections were made yesterday, they would be of equal value as if made, as Mr. Collyer says, in the 17th century. Mr. Hamilton's statement does not touch Mr. Collyer's reputation; and relying, as we must, on the word of the latter gentleman, we think Mr. Hamilton's deductions too hastily made. The folio of 1632 has, after all, done much to give us something like an amended text of Shakespeare. Φ

HOW MANY EGGS DOES THE CUCKOO LAY?—It is generally supposed that the cuckoo lays only one egg. This is incorrect. Colonel Montagu says, "I dissected a female cuckoo early in May, which weighed 3½ ozs. The ovaries and uterus were vastly distended, but I imagine no egg had been laid. The largest vitellus appeared to be of sufficient size to separate from the ovarium, but it was still attached. The next egg in succession was not one quarter so large. The third and fourth were nearly of the same size, not more than half as large as the second. There were two others rather inferior, and a seventh not half so large as these." Colonel Montagu adds, "These may be considered as the portion of eggs destined to be produced within the season." The cuckoo divides her favours evidently, and is often found "absent without leave."

COLOURS OF SHELLS.—The endless diversities of shades and colours, varying from the sober coat of the garden snail to the delicate and glowing tints which are diffused over some of the finer species, in the infinite profusion of undulations, clouds, spots, bands, and reticulated figures, with which those architects enrich their structures, are strongly calculated to attract attention, and excite investigation. The instrument by which they paint those beautiful colours is called "the mantle," and is placed in the anterior part of the body. It is furnished with pores, through which the secreted fluid is carried, and applied to enlarge the volume of the shell.

MANAGEMENT OF AQUARIA.

THE "aquarium mania" may be considered as fairly dead: it died out properly and completely; but the aquarium remains, and every earnest student of botany and zoology will prize it as a triumph of art acting as the handmaid of science. We rarely hear of "aquarians in trouble" now-a-days, because the thousands who set up aquaria, without the least idea that to be successful they must be managed on philosophical principles, have long ago given them up as "troublesome;" but the scientific observer and the intelligent cultivator of instructive recreations agree in regarding the aquarium as a valuable means of bringing together many curious objects from various departments of Nature. What a store of valuable information would it have furnished to Mr. Yarrell for the enrichment of his work on fishes? How many of the mistakes of Professor Johnston would have been corrected had he possessed such means as we now have for the study of zoophytes? And how much earlier would have been dissipated the doubts that long hung like dark clouds over the classification of Infusoria, and the question as to animal or vegetable among various divisions of the Protozoa, had the important *balance* of forces been earlier arrived at? How poor the resources of the microscopist in the absence of a reservoir to guage with the dipping tube; how unsatisfactory the researches of the marine phytologist without the help of a tank in which to note the effects of light on Algæ; how narrowed the field of labour for botanist and zoologist alike without such a means of having always at hand living specimens of the least known but most interesting aquatic plants and animals.

There is no necessity for me to go over old ground, and tell a thrice-told tale. Most of the readers of this work have aquaria,

which they would improve as experience might direct them; and many who have not yet essayed to make friendship with Neptune and the many sea and river gods that might be invoked to favour the enterprise, would speedily begin if certain doubts and difficulties were removed from their minds.

Granting tanks are properly constructed, so that none of the metal used can come into contact with the water, how will you place them as regards the light? I have a variety of tanks; some used for ornament, and others for purposes of study only. Some of the latter are objects that no casual observer would tolerate; but toleration is not expected, for only a few scientific friends ever see them beside myself. The most important result of my experience in tank management is this lesson, applicable to all kinds of vessels—leave them alone. An aquarium can neither look well, nor do well, whether used for ornament or facility for scientific observation, unless it is allowed very much indeed to take care of itself. The whole secret of securing success, is to make the first arrangements on sound principles, and then to consider whether the light in which they are to be placed is likely to prosper or ruin them. For marine objects there is no form of tank so generally safe as the "slope-back," invented by Mr. Warrington. The light finds its way into the water almost vertically in such a vessel, and that is in accordance with Nature. A cool position, safe from frost, vertical light, little or no side-light, and a general if not total exclusion of sunshine; these are the conditions as to light under which success has been and will be most general. But vessels kept for ornamental purposes cannot always be so placed, and ingenuity must devise the means of compensation. A river tank will bear more light than a marine vessel. Sunshine may be permitted occasionally to stream through it, to the delight of bleak and minnows, which gambol rarely when the scene is thus made magical for awhile; but a constant flood of full daylight into and through a river tank quickly fouls the water by inducing a rapid growth of minute vegetable forms, and therefore the conditions just recited should not be forgotten. Suppose a rectangular tank, transparent on all four sides, to be placed in a window high enough for the light to pass through it. In a south aspect such a vessel will become opaque in ten days, and, *if left alone*, will become bright again in a fortnight or three weeks. It will then assume a muddy hue once more, and thus cause vexation upon vexation, and be at last pronounced a failure. But, instead of thus exposing it to an excess of light, paste over the side next the window a sheet of green tissue-paper; let the window be open all the summer, night and day, and keep the blind always down, and from the moment you have adopted such an arrangement you will cease to complain of the uncertainty that attends the management of aquaria. Such a tank, so managed, adorns the hall of my residence. It is emptied, cleaned, and refitted once a-year; beyond that it has no attention whatever, except an occasional cleansing of the front plate of glass, and it is always beautiful. The fishes in it are mostly old friends, and there has been but one death amongst them for three years past. Some years ago I had a collection of tame minnows and Prussian carp. They were a thousand times more worthy the admiration of a "discerning public" than the horrible "talking and performing fish," which, by the way, is a quadruped, and not a fish at all. Those carp and minnows were transferred from a cool window in a north room, where they had been under instruction for the space of eighteen months, to a bench in the garden, over which I intended to fix a canopy of calico. Alas! the sun found his way to the bench before the canopy was ready for its place—the water in one day became a dark mass of green confervoid soup. In three days the carp were all dead, many of the

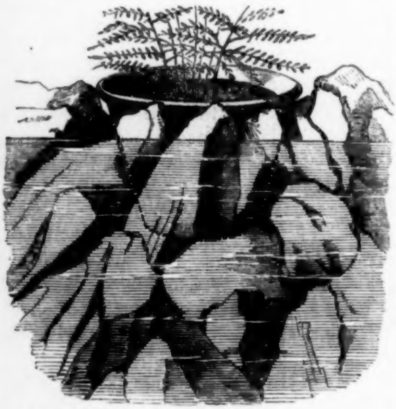
minnows were dead also, but one or two of them survived, and at a sad price I learnt one more lesson as to the effects of light upon aquaria. A powerful sunshine in a room will, of course, not be so dangerous as on a wooden bench between two hot walls; but it is a question of degree only, and whoever desires to see a beautiful collection of river plants and animals, must be prepared to shut out excess of light if the position of the vessel be such as to admit it. Many readers will, doubtless, be surprised when I assure them that the vegetation ordinarily used in river tanks is altogether unsuitable. If tanks are to be managed on the self-supporting principle, away with the flowering rushes and water violets, water milfoil, and all the tribe of *Nymphæa*, and trust for the supply of oxygen to the spontaneously produced vegetation, of which there will be plenty, if the foolish system of scrubbing and cleaning and changing the water be given up. Once a-year is often enough to change the water, and it only needs to be changed then in order to lay down fresh pebbles in the place of those which have become black, and to make such other changes as taste may suggest, for variety's sake. The majority of aquatic plants do well only for a time. After awhile they rot at the base, and float away from their moorings, or get so sickly for want of deep soil to root in, and hot sunshine to stimulate their growth, as to be a nuisance. Exceptions may be made in favour of *Valisneria spiralis*, the best of all aquarium plants; *Anacharis alsinastrum*, which will thrive under the most trying of circumstances; *Stratiotes aloides*, which floats about, grows well in a subdued light, and occasionally anchors itself by means of its long cord-like roots; *Hydrocharis morsus-ranæ*, which floats on the surface, and does well in most positions; and the three *Lemnas, minor, trisulca*, and *polyrhiza*. Any of these may be permanently planted, and it will be very exceptional indeed if they do not prosper, especially if there are no *Lymnea*, which are very destructive. With the exception of these, trust to the *Confervæ*, the *Oscillatorieæ, Vaucheria ungeri*, and other low forms of vegetation, which come in their own way in every tank which is left undisturbed, and there will be plenty of surface for them to rejoice upon if only the front plate be kept clean, by means of a sponge attached to a stick.

This proscription of the very plants which have been considered the most attractive features of the aquarium may create surprise. Let not the surprise be changed to fear; you may have them all, and many other beautiful aquatics, if you take care not to plant them. I use a very large variety of British and exotic plants as tank decorations, and amongst the number of my favourites are ferns. The cut at the head of this article represents a tank which I lately fitted expressly as a water fernery, and it accomplishes all that can be desired as a decorative object without violating any principle of aquarium philosophy. Instead of planting in the aquarium, pot plants only are used. They are grown expressly for the purpose, and may be changed as often as the extent of the stock of plants will allow, so as to vary the scene with the changes of the seasons.

To carry out this scheme all that is necessary is to model a rockery to the shape of the tank. But it should not be fixed, for it may be desirable to remove the whole or part of it at some time or other, for the purpose of effecting a change in the decorations. Use pumice-stone or coke. If the latter, dip it twice in a batter of Portland, as lately advised by Mr. Noteworthy, and you will secure the desideratum of a substantial and handsome rockery, weighing only a few pounds instead of two or three hundred weight. In the tank, which forms the subject of illustration, the rock-work consists of a series of arches, bearing eight summits, to correspond with the eight sides of the vessel, the whole resting on four shafts

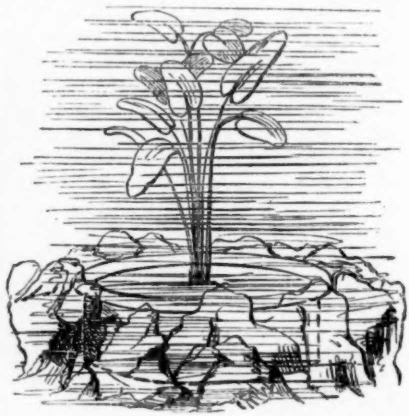
from which the arches spring. The eight summits and the centre are hollow, that is, to use gardeners' language, they have "pockets" of the proper width and depth to receive flower-pots of what we call 48-size, the size most used, and in which very large specimen-plants may be grown.

By this plan you accomplish two objects; you conform to the best principles of aquarium management, by keeping out of the tank all such plants as are unsuitable, and you indulge your ferns with a course of treatment which suits a certain number best of any.



Flower-pot encased in Rock-work, *partly* plunged in Water, for Ferns.

I was at an expense of some pounds last spring to make a tank with supply from the New River, and siphon pipe to keep the water to a proper level, expressly to grow two of our commonest ferns, *Osmunda regalis* and *Athyrium f.f.* They are in 9-inch pots, plunged six inches deep, and have become magnificent specimens, well worthy of the trouble bestowed upon them. Yet, the royal fern is one of the very worst for pot-culture under ordinary management. In the mode of managing tanks which I am now advocating, the ferns need only to be properly chosen, and their growth will be marvellously perfect and luxuriant, provided the bottoms of the pots only touch the surface of the water, or are plunged in it not more than two or three inches. When their season is over, their removal is a simple affair of lifting out the pot, which is easily replaced with another, and so on *ad infinitum*. The lovely *Cystopteris fragilis*, planted in one of Pascall's shallow cutting-pots, surfaced round with *Lycopodium denticulatum*, makes a beautiful ornament on the summit of a cromlech in one of my tanks. It is usually two inches deep in the water; it grows with vigour and



Flower-pot (flat shape, as in sketch) encased in Rock-work, *wholly* plunged in Water, for Lilies.

delicacy, throws up numbers of new crowns, and is much more persistent than under any other method of management. If it casts its fronds early, I cut them close over, and a new crop starts at once; but it rarely shows a brown frond all the season, its habit is so changed by this truly aquatic mode of culture, which is favoured by those convenient conditions, shelter and shade.

The ferns so used in the tank, represented above are: *Scolopendrium angustifolium, Onoclea sensibilis, Asplenium adiantum nigrum, Osmunda gracilis. Platyloma*

falcata, *Pteris serrulata*, *Polystichium coriaceum*, and *Cyrtomium falcatum*. The last four are in front and are drawn in detail. The centre is occupied with the *Athyrium f. f.*, the true Lady Fern. There are at least a hundred fern species and varieties which might be used in the same way, and which, when so used, could be preserved in a cold frame or greenhouse, and require but the most ordinary care in cultivation. If we admitted flowering plants, as we certainly ought, the names of those suitable are legion. The pretty blue-flowered *Sisyrinchium anceps* is a first-rate thing for plunging in the pockets, and with a set of these all round and a fine Calla in the centre, you would have a glorious garden of water-flowers without getting involved in a single one of the many meshes that beset ill-advised experiments with the aquarium. True aquatics, such as water-lilies, water-milfoil, starwort, potamogeton, sweet-rush, water-plantain, marsh-marigold, water-cress, and others, which it would be ruin to a tank to plant in it, might be grown in pots ready cased in blocks of rock-work and plunged in a stone trough, cistern, or fish-pond, and during their flowering season lifted out and lowered into the aquarium, to adorn it for a time, and then be removed back to their original quarters. Those who have my "Rustic Adornments" will find, at pages 131 and 401, lists of plants in varieties sufficient to keep almost any number of tanks gay the whole year round, and the mode of using them here recommended offers the additional advantage that you have not to plant and wait for the result, and then perhaps be disappointed, but the result is ascertained at once; if one of a set of plants is too dwarf, too coarse, or otherwise unfit to range with the rest, another can be substituted, and thus you secure ferns and flowers apparently growing *in situ*, with the simplicity of arranging a few specimens on an ordinary flower-stand.

SHIRLEY HIBBERD.

HARMONIES OF NATURE REFLECTED IN ART.

THE NETTLE AND THE WASP.

THE NETTLES (*Urtica*, Linn.) are so called from the burning sensation which their stings produce. We have three native species, which are arranged under the Linnæan class MONŒCIA, from the stamens and pistils being usually produced in separate flowers, though growing upon the same plant; sometimes, however, flowers with stamens only are found on one plant, and those with pistils only on another; but according to the natural system, they belong to the order URTICACEÆ, Jussieu. Under the order are associated with it numerous important plants, arranged under sub-orders in the following manner:—1, *Urticeæ*, containing the nettles; 2, *Cannabineæ*, the hemp and hop; 3, *Moreæ*, mulberry, the leaves of which are so valuable as food for the silk-worm; 4, *Artocarpeæ*, the famous bread-fruit, which forms so important an article of food in the Pacific Islands, the poison-tree or upas of Java, the remarkable cow-tree of South America, from which flows a nutritive beverage like milk, the highly-esteemed and valuable fruit the fig, and some plants from which the useful Indian-rubber is procured.

The *nettle* is one of the most common of our wayside plants, and there are few persons who have rambled in the country lanes and waste places that have not become more or less acquainted with it, from its being furnished with those remarkable organs of defence the stings, which so readily perforate the obtrusive hand, and cause a smarting,

burning pain, which is instantaneously felt, and is continued for some length of time after the wound has been inflicted. If the plant is carefully examined, it will be seen that it is clothed all over with simple hairs; but amongst these hairs are scattered a greater or less number of other and larger ones, which are swollen at the base. If one of these is removed from the stem with the point of a sharp instrument, and placed under the microscope, it will be seen as represented in the accompanying illustration (Fig. 1). The

FIG. 1.

FIG. 2.

upper sharp-pointed process is a hollow tube filled with a pellucid fluid, which is secreted by a little gland at the base of the dilated cellular receptacle, and is there held in reserve for use. It will thus be observed what an admirable though simple contrivance of defence this sting is; for, if the slightest pressure is made upon the tube or base of it, the fluid which it contains is forced through the opening at the apex, where it is so finely pointed that it readily enters any soft substance, such as the skin, and then, from the acrid nature of the fluid (called by chemists *formic acid*) which is pressed through, produces immediately that pain and burning sensation which is experienced. All the species of the nettle are furnished with these stings, but the poison of some of them is much more virulent than others.

The difference between the sting of the nettle and that of insects, such as the bee and the wasp, is so remarkable, that we shall do well in our rambles to consider it, and ponder over the wonderful adaptation of the means used to attain the purposes for which each is made by *Him* who made all things perfect.

That very busy, active, little insect, the common wasp, which by many people is looked upon with fear and dread, is not as quarrelsome an insect as is generally supposed, but is usually harmless unless disturbed in its work, or in any way provoked; but when it is enraged it becomes pugnacious and revengeful, and uses the formidable weapon with which it is furnished with great agility. If we capture one of these insects, and, after having killed it, remove the last ring of the body together with the sting, and carefully separate the surrounding parts from it, it will be seen, under a high magnifying power, to be formed of a long taper-pointed process, furnished at the base with cells and glands, and on each side arise jointed arms, the end joints being covered with hairs (Fig. 2). The sting will be seen to be flattened towards the point like a minute dagger, one edge being simple and cutting, the other serrated with eight to ten sharp-pointed teeth like a saw, having the points towards the base; a little below the apex is the opening into a tube, which runs the whole length of the dagger, and communicates with a receptacle at the base, where the glands are which secrete the poisonous fluid. The opening into the tube below the apex is protected by another serrated process, which seems to act as a valve, and allows the escape of the fluid, but protects the aperture, and

keeps it free from obstruction. By this admirable contrivance it will be seen that the instrument, from its sharp cutting edge on one side, and the way in which the points of the teeth are directed on the other, readily penetrates any soft substance, and that in the act of withdrawing it from the wound, it cuts its way out like a saw, and in doing this it forms a jagged wound; consequently the poisonous fluid which has been conveyed into it more readily produces its specific action, accident or use some of them become injured or destroyed, there are abundance of others to supply their place, consequently a simple constructed organ is all that is required; but in the wasp it is different, for it is furnished with only one sting, and if that from any cause became injured, and it was deprived of its important organ, the loss would be irreparable; therefore the All-wise Creator has so fashioned it as to be most perfect for the use for which it was made,

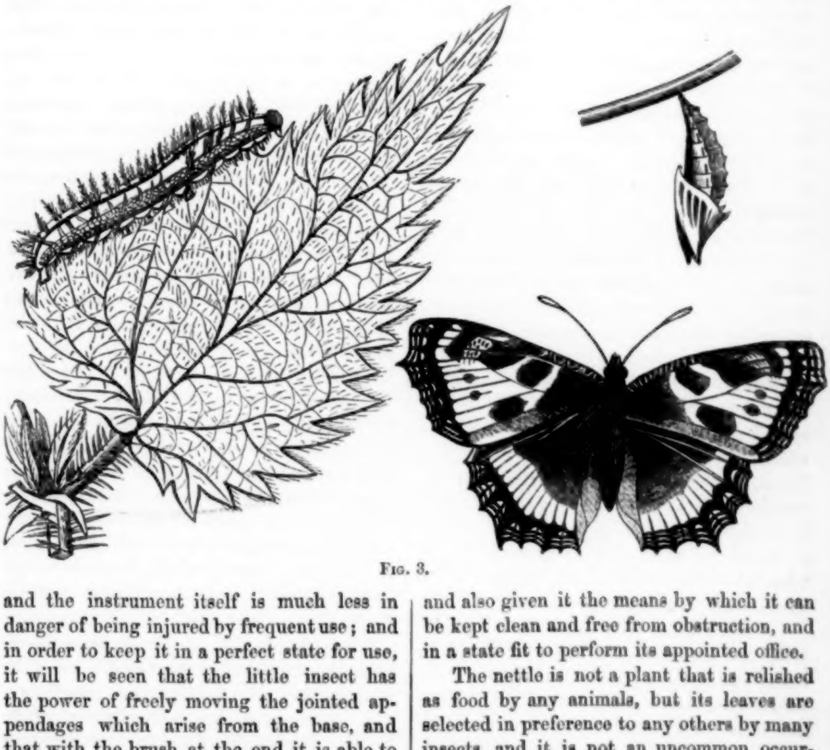


Fig. 3.

and the instrument itself is much less in danger of being injured by frequent use; and in order to keep it in a perfect state for use, it will be seen that the little insect has the power of freely moving the jointed appendages which arise from the base, and that with the brush at the end it is able to clean it after it has been used, and clear it from any particles that may adhere to it. We thus see that in the nettle the stings are of the most simple construction; and if by and also given it the means by which it can be kept clean and free from obstruction, and in a state fit to perform its appointed office.

The nettle is not a plant that is relished as food by any animals, but its leaves are selected in preference to any others by many insects, and it is not an uncommon occurrence to see large patches of them entirely deprived of their leaves. This is generally done by the caterpillar of the beautiful nettle butterfly (*Vanessa urtica*, Fig. 3) feeding upon

them, and those who wish to see the wonderful transformation of this interesting tribe of insects, should take some of the largest caterpillars that they can find feeding upon the leaves of the nettle, and place them in a cage made for the purpose, or an ordinary bird-cage, covered with thin muslin or lace, to prevent their escape. Then feed them with the fresh leaves of the nettle until they have arrived at maturity; after which they become listless, and soon change into the pupa state, and thus remain dormant for a time. They then burst the hard case which covers them, and the perfect butterfly comes forth decked in all its brilliant colours, and is soon ready for flight, and no one, however much he may have disliked the unattractive caterpillar, will now fail to admire the perfect insect clothed in its beautifully-coloured and exquisitely-arranged minute scale-like feathers. The butterfly, soon after it becomes fully developed, deposits a considerable number of small roundish eggs, and always places them on or near the plant suited for the young caterpillar which each egg contains, and in the course of a short time, by the aid of the heat of the sun, breaks its delicate shell. Thus, without much difficulty or trouble, may be observed all the remarkable transformations which the progeny of the butterfly undergoes. Let us, however, inquire more particularly into the changes which this insect passes through in the different stages of its existence, and in so doing, we shall obtain a general idea of what takes place in the metamorphosis of the whole tribe of butterflies and moths.

If the delicate little eggs which the butterfly has deposited are collected, it will be found that about a hundred of them do not weigh more than a grain, consequently, when the little caterpillar is liberated from its shell, it is a very minute, delicate, little creature; it soon, however, increases in size, so that in a few days its body is so much enlarged that its outer coat, or skin, is unable to contain it; consequently, this is cast off, and the body is then seen to have increased in size. Soon after this change of its coat it begins again to feed upon the leaves of the nettle with greater avidity, and in a few more days it is so much grown as to again require a new and larger skin. It goes through this change five times, and each time it has become considerably larger. It will be observed that a few hours before each time that the lava is ready to cast its skin, that it ceases to eat, and it usually attaches itself on the under side of the leaf of the plant, and there awaits its change. It has the appearance of being uneasy, and the whole body is wrinkled and contracted in length, the skin becomes dry and shrivelled, and is gradually separated from the new, but yet delicate, skin beneath it. At length, after some powerful efforts of the larva, the old skin is cracked, and it gradually presses itself through the opening. It then appears for some time very delicate and ill-proportioned, from the head being much larger in proportion to the body, but it will be seen that the head does not increase in size with the body, but remains the same until the next change of the skin. In a few hours after this change has taken place, the caterpillar begins again to feed voraciously, but more especially so after the last skin has been changed, during which period its growth is much more rapid than at any previous time. When the caterpillar has attained its full growth it ceases to eat, becomes very restless, and is diminished in size and weight; it completely evacuates the contents of the alimentary canal, and then suspends itself by its hinder legs, and attaches itself by a silken web upon a branch, or other convenient object, with its head hanging downwards, and thus it awaits its next and important transformation, which takes place in from ten to twenty hours. During this time the body becomes contracted, and looks dry and shrivelled; the four segments nearest the head become larger than the others, which are repeatedly contracted and expanded; at length the skin

bursts down the back and at the head, and with exertion the insect frees itself entirely from its skin. It has now attained what is called the *chrysalis*, or *pupa*, state, though the change is not yet completed; for it will be seen that when the skin is separated, that the legs and antennæ, as well as the wings, are separate from the body, but, after a few seconds, the pupa makes several powerful respiratory efforts. During this period the abdominal segments become more contracted, the wings, though small, are enlarged and extended along the sides and under part of the body. When the skin is being thrown off there is exuded beneath it a peculiar transparent fluid, which facilitated its removal. This fluid, which is diffused over the whole body, and amongst the limbs, soon becomes thickened by evaporation, and when it is quite dry it unites the limbs and wings to the sides of the body, forming a compact, hard, horn-like covering to the whole. The change is now completed, and the pupa perfectly formed. Thus we have seen that the minute eggs, after a certain period, become hatched, and a small caterpillar is formed, which feeds upon the grosser substance of the nettle, and that after it has attained its full growth it enters upon its pupa state, having acquired a very different form, and some new external organs, and at the same time its internal organization has undergone a fresh arrangement. The pupa now remains in a state of perfect quiescence, and continues thus in an entire abstinence from all food for a variable period, which appears to depend upon the heat of the weather, or other external circumstances. Thus, if the lava changes into the pupa state, in the middle of summer it becomes transformed into the perfect butterfly in from eight to ten days; if, however, this change takes place in the earlier and cooler part of summer, it remains in that state about fourteen days, but if it enters the pupa state towards the end of summer, when the temperature of the atmosphere is daily declining, it remains in that state through the cold of winter until the return of genial spring sets in. It has been proved by Reaumur that if the pupa is placed in an ice-house, its development into the perfect butterfly may be retarded for two or three years; on the other hand, if some of the pupa of the same age be placed in a hot-house, even in the midst of winter, they become developed into the perfect insect in from ten to fourteen days. A certain period of repose is, however, absolutely necessary, for the insect now undergoes an entire change of form and habit, and its internal structure is metamorphosed to enable it to perform the new functions for which it is destined, for, from the change which its body has gone through, it is now unable to enjoy those pleasures which it did in its previous state. A short time before the pupa changes into the perfect insect, all the external parts are seen to be more developed; it becomes restless, and moves about more vigorously; at length it bursts its case, and speedily disengages itself, stands on the outside of its late prison with the wings dependent; it then makes several powerful respiratory efforts. At each respiration the wings may be seen to become more expanded and larger, which is caused by the enlargement and extension of the air-tubes, and their accompanying circulating vessels which ramify through them. In a very short time these organs attain their full development both of beauty and form; the insect then remains at rest for several hours to gain strength, and for the hardening and consolidation of the rest of the body; it then takes to flight, but how changed in form, how different in habit!

The form of the insect is now so totally changed, that it would be difficult to believe it the same creature unless we had watched it in its different states and changes, for now, from its being a disagreeable and repulsive creeping creature, which few people admire or cherish, feeding and grovelling upon the

grosser material of plants, it has become an elegant insect, clothed in garments of splendid colours, and takes its aerial flights in fitful gambols, rejoicing in its liberty and sportive in the genial sunbeams' glow, sipping the sweet odoriferous nectar with its spiral tongue from every blooming flower. How wonderful and complete is the metamorphosis, not only in its external character, but also in the internal arrangement of its organization; for now it has thrown off its strong mandibles, and is no longer able to masticate its food; in their place is a long spiral tongue or proboscis, which is only fitted for the absorption of fluids. Consequently its digestive and assimilating organs have also changed their character, as now they have only fluids to digest instead of the harder cells and fibres of the plant on which it fed. All these remarkable modifications of structure are means by which every part of the body in its different states are beautifully adapted to the habits and wants of the individual, and the insect thus becomes an important agent in carrying on the operations of Nature in the various works of creation.

The eggs which the butterfly deposits are very numerous. From these arise an equal number of caterpillars, and from their feeding upon the nettle, they prevent its overgrowth to the detriment of other and more delicately-constituted plants. But the caterpillars themselves are the food of many birds, who greedily hunt them out; and some flies of the ichneumon tribe deposit their larva beneath their skins, and feed upon them, even during the time that they are undergoing their change, and eventually destroy them. Thus one part of creation is made dependent upon another, and the harmony of the whole maintained in a wonderful order.

The metamorphosis of the butterfly will, no doubt, remind the classical scholar of that most interesting and elegant of all the fables of antiquity which have come down to us—that of Psyche. Great learning and laborious research has been bestowed by many men in the endeavour to trace out the origin of this myth; but nothing appears to be really known of it anterior to the time of Apuleius, who lived, it is believed, towards the close of the second century of the Christian era. In his work, "The Metamorphosis," the title of which was afterwards changed to that of "The Golden Ass;" not, however, it is thought, by the author himself, but probably on account of its affinity to Lucian's story of "The Ass," the epithet of "golden" being added as a mark of admiration. The episode of Psyche is introduced in the latter part of the fourth book, and it is continued in the fifth and sixth; but the simplicity of the myth, as no doubt it was in its original state, is here greatly distorted by many puerilities and absurdities.

The origin of this symbolical fable may be traced back to a period much anterior to the time of Apuleius, especially through the medium of ancient gems.

The ancient Egyptians likened the supposed renewal of the earth after the flood, and the return of Time, to a second infancy; and depicted the renovation of the world under the emblem of a child, and called him *Eros*, that is to say, *Love*. Hesiod, in his "Theogony," l. 120, in alluding to the state of Nature after the deluge, says: "First Chaos was produced, then Tellus, then Love, the most beautiful of the gods; Love the soother and softener, who relaxed the weary limbs." Aristophanes, in his comedy of the "Birds," l. 695, says, in his poetical language of the same event: "Sable-winged night then produced an egg, whence sprouted up, like a blossom, *Eros*, the lovely and desirable, with his glossy golden wings." Love is here used emblematic of the Divine mercy for the human race. The Greeks introduced as its companion, the personification of the soul, originally in the form of the aurelia, or

butterfly. Plutarch, in the second book of his "Symposiacon," says: "A chrysalis, after being stiffened and cracked from dryness, emits through its opening a second animal with wings, which is called Psyche."

"The winged animal," Mrs. Strutt says,* "thus designated by Plutarch under the name of Psyche, the word by which the Greeks expressed likewise the soul, is in all probability that which Ælian calls *Pyraustes* (Πυραύστης), a word denoting the attractive influence which light or fire exercises upon the moth. This truth in natural philosophy is poetically depicted to the eye by the device, which

Fig. 4.

we see on many ancient gems, of Cupid holding a butterfly over his torch (Fig. 4), by which act is at the same time typified the suffering of the soul from being subjugated by passion; and, mystically, its purification 'as by fire' from the defilement of matter. Such an ingenious allegory was not likely to escape the attention of the poets, and we accordingly find it alluded to by them at an early period. Thus Meleager, B.C. 160, plays very prettily, in one of his epigrams, upon the double meaning of the word *Psyche*, as a moth and as the soul, introducing it in immediate connection with *Eros*, or Love."

The same authoress, in allusion to the caterpillar says: "At the close of its final existence as a worm, crawling upon this lower earth, an emblem of man encumbered with his material body, this insect lies dead as it were for a season, in a sort of tomb or grave, which bears a great resemblance to the mummies found in the Egyptian tombs. In this state of darkness," the authoress continues, "it remains throughout the gloom of winter; at the joyous return of spring, the torpid chrysalis bursts its bonds, leaves its earthly body (or rather case), never more to be resumed, and soars up towards heaven, decked in the most gorgeous attire, and rejoicing in new life; a beauteous type of the celestial soul freed from the restraints of matter, and exulting in liberty and light."

"Like other animal symbols," says Payne Knight, in his "Inquiry into the Symbolical Language of the Ancients," "as the owl, under which Minerva was first depicted, this of Psyche was by degrees melted into the human form, the original wings only being retained to mark its meaning. So elegant an allegory would naturally be a favourite subject of art among a refined and ingenious people; and it accordingly appears to have been diversified and repeated by the Greek sculptors more than any other which this system of emanation so favourable to art could have formed."

It would take us far beyond the province of this work to enumerate all the interpretations which have been given of this fable, for there are few authors who have written upon ancient literature or the arts but have given their ideas as to its symbolical meaning; in the arts, especially that of sculpture and engraving upon gems and stones, even down

* A very beautiful and talented work, "The Story of Psyche, with a Classical Inquiry into the Signification and Origin of the Fable," by Elizabeth Strutt; with designs in outline by John Gibson, Esq., R.A.: to which we are chiefly indebted for the remarks here made in allusion to the fable.

to our own times, it is one of the most favourite subjects treated, and every collection, either of ancient or modern art, has some representation of the subject.

That there is a pure and lofty signification symbolically represented in the fable there can be no doubt. Archdeacon Nares, in his "Remarks upon the Ballet of Cupid and Psyche," says: "Psyche, the human soul, formed originally of exquisite purity and beauty, is placed in a state of refined happiness, of which, however, some of the principal causes are concealed. Amidst the enjoyments offered to her, *one prohibition* only is interposed. It is required, as the condition on which her happiness depends, that she shall not attempt to gain *forbidden* knowledge concerning the Author of her blissful state. Contrary to her own better judgment, she is over-persuaded by wicked and malicious suggestions, and actually acquires the knowledge she was so strictly ordered not to seek. Her curiosity and disobedience are fatal. She is driven from her state of happiness, and sent to wander over the earth, amidst innumerable difficulties and trials; yet constantly, whenever she is in any danger of sinking under the severity of her situation, some supernatural interposition (that is, some divine revelation) prevents her from despairing, and kindly enables her to perform that which was naturally beyond her powers. Even in the first moment of her condemnation, her judges, we are told, showed manifest tokens of an affection to which every other consideration was subordinate. And, finally, when she is depressed even to hell by the difficulties which assail her, divine love—for so, with Mr. Bryant, I am inclined to think Cupid (Eros)—interposes for her relief, and not only rescues her from the horrors of that dreadful place, but, uniting her with himself, places her for ever in a state of transcendant exaltation and of perfect bliss." "Such," continues the reverend commentator, "is this extraordinary allegory, which, that I have not in any respect misinterpreted, may be seen by recurrence to Apuleius, Fulgentius, Baucer. Now, if it be true, as I believe has been conjectured, that the mystic fables and hieroglyphics of the Egyptians concealed, as beneath a veil, these important truths, which at first were known universally to all men, but which in other places, except when preserved by divine interference were lost, corrupted, or forgotten—if this, I say, be true, if it be even probable, why may we not consider this fable of Cupid and Psyche as a singular and very curious instance of the perfect preservation of one of these religious allegories? The Greeks, it is well known, even by their own confession, borrowed from Egypt all their mythology; but, if this interpretation be admitted, we can hardly expect to discover, among all their thefts, another of any comparable importance." ("Essays," 1810.)

With regard to the way in which this subject has been treated by the imagination and skilful hand of the artist, the most ancient illustrations known are probably those found on gems, in which Cupid is represented holding a butterfly over a flaming torch (Fig. 4), which we have already alluded to. At a later period the body of the butterfly is transformed into that of a beautiful female figure, with the wings of the butterfly attached between the shoulders. After this period Psyche always appears to be thus represented. At no period of art has the fable of Psyche been more beautifully and elegantly illustrated than by Mr. John Gibson, R.A., in whose studio at Rome the whole series may be advantageously seen. Those who may be disposed to study the subject more at length will find it treated with much skill and learning, and beautifully illustrated from drawings by Mr. Gibson, in Mrs. Strutt's work above referred to; by Mrs. H. Tighe; D'Israeli's "Curiosities of Literature;" Clarke's "Travels," etc.

RICHARD DEAKIN, M.D.

WHAT IS A DIATOM?

Some ten years ago (how time does run on!—it seems but as yesterday), a young man on a visit to the Professor of Natural History in the new Queen's College, then the most recent attraction of "the beautiful city of Cork," found himself unexpectedly alone amongst strangers. By a mysterious decree of Providence his friend had been taken alarmingly ill the night before, was then and for weeks afterwards invisible to all but his doctor and two amiable and accomplished daughters. What was to be done? Happily, a work on the Diatomaceæ had been projected, the illustrations to which had been confided to his care; and, to begin upon, four slips of glass had been given him, labelled "Aberdeen," "Premnay Peat," "Cantire," and "Loch Mourne," names now "familiar as household words" to the initiated in these mysteries. On the central third of each of these slips, protected by a square of very thin glass, was to all appearance a little fine white dust covered with gum; the particles composing which dust, when held up to a bright light, flashed like rubies, diamonds, emeralds—a perfect coruscation of fairy gems.

And these were Diatomaceæ? Our young microscopist, like some of those who now inquire of him, had scarcely heard the word before. To while away the time he now sat down to these four slides, with the concise yet comprehensive instructions from his great captain, to "draw all he saw before him:" not bad training this for eye, and hand, and patience, as all who know what a fine mounting of similar gatherings, where forms differing in age by centuries may be included, is like. Slowly then during these weeks did the work progress, and such was the fascination produced by their beauty in the artist's mind, that day after day he sat at them; night after night, the morning sun frequently rising ere his couch was sought for brief necessary repose. An occasional stroll through the fine scenery in the immediate neighbourhood, for health and recreation, afforded also an abundance of living specimens of many of the forms whose skeletons he was engaged in depicting, in addition to Desmidieæ and other objects of interest to the microscopist. The Vice-President of the College, with the warm-heartedness of a true Irishman, took compassion on the stranger, asking him in occasionally to tea and a social evening, when by other professors and visitors the question was repeatedly put with which our chapter is headed, "What is a Diatom?" To these learned fellows, versed in all the circle of the sciences, the reply that "the siliceous portion of the infusoria of Ehrenberg, called by him 'Bacillaria,' had more recently had this name given to them," served its immediate purpose of conveying ideas on the subject sufficient for most of the questioners. To add to the interest of the evening, the microscope was on two or three occasions brought in, and some of the most elegant forms exhibited.

But some of the readers of Recreative Science may be none the wiser for such a definition, which, it must be admitted, is after all vague enough; since, translated into simpler language, it means little more than that the name had been changed of some minute moving bodies found by the microscope in water, together with such animalcules as our forefathers used to breed from infusions of chopped hay, tea-leaves, and so on, and hence called "Infusoria." The most prominent distinguishing feature in the portion in question being the possession of shields or shells that resist the action of fire and concentrated acids, being formed of flint.

Imagine, now, that we have a common round snuff-box before us; we see that it is in two pieces, the top or lid, and the bottom part, or the box proper. This will give a tolerable idea of many of the Diatomaceæ; such are "discoid," or of a disc-like shape. Looking down upon our box, with the eyes directly over its centre, we just see that its shape is round, and of its *form* should from such a point of view learn nothing more. If now we turn it so as to display its edge, its thickness, the form of the mouldings, and the way in which the two pieces of which it is composed fit together, are apparent. In a somewhat similar way a Diatom is made up of two portions, or "valves," externally convex, which when united enclose a cavity, as may be rendered plainer by Fig. 1.

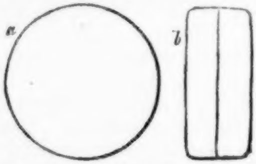


FIG. 1.—Coscinodiscus in outline. *a*, side view; *b*, front vie

To get a full knowledge of its outward form, we must turn our Diatom upon edge, or, as this can be seldom done, except with the very largest, examples must be sought for on the slide under examination which present this aspect. In nearly all the Diatomaceæ, the shells are marked with lines, or dots, arranged in such wise as to form patterns of the most elegant tracery. Of these we shall have more to say presently.

If now, instead of a round, we take a long, oval box, we shall obtain an idea of the shape of another considerable portion of the Diatomaceæ, as in Fig. 2.

The two valves of a Diatom, when in union, constitute a "frustule;" they are generally alike, but in some few forms the upper and lower valves are different. The flinty nature of their shells or valves has already been mentioned. Closely applied within the valve is a delicate lining membrane, of the

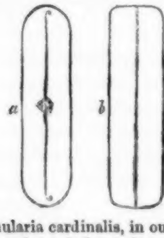


FIG. 2.—Pinnularia cardinalis, in outline. *a*, side view; *b*, front view.

greatest importance in the economy of the little being; to this, as the term is of common use in speaking of vegetable cell-growth, it will be of advantage to give the correct term, "primordial utricle," at once. This membrane, from its extreme delicacy, can seldom be distinctly seen until its collapse and separation by death from the valve; it, too, is occasionally marked with dots or lines. In or near the centre of every Diatom is a small-rounded body, the "nucleus" connected by delicate threads of "protoplasm," with little patches of soft substance, generally of

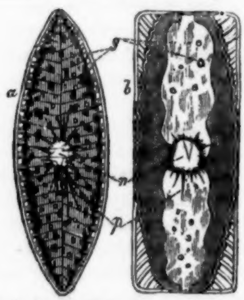


FIG. 3.—Surirella biseriata, from a living specimen. *a*, side view; *b*, front view; *n*, nucleus; *p*, protoplasmic threads; *g*, granules, moving towards and from the nucleus.

a bright brown colour, the "endochrome," which means simply "internal colouring matter." These points may be more clearly understood by looking at Fig. 3.

Carefully executed studies of the arrangement of the endochrome are still a desideratum, one which the late learned Professor Smith hoped at some future day to supply, and for which he had, previous to his death, collected a goodly number of drawings. There is no doubt it may sometimes assist towards the ready distinction of species in the living state, and its bright colours and elegant arrangement would make a very handsome series of illustrations; we know of few prettier than the common Cymatopleura solea (Fig. 4).

FIG. 4.—Cymatopleura solea, from the life. *a*, side view; *b*, front view; *c*, patches of endochrome, which, on the front view, is seen to be mostly in plates.

A circulation of granules has been witnessed in some of the Diatomaceæ. We have ourselves seen it in the Surirella (Fig. 3), and two or three other forms, and have spent much time in attempts to ascertain if it be not generally present. The examination is one requiring, however, such perfect management of all the details connected with glasses, source of light, illumination, and so on, with time at unlimited command, that we obtained no satisfactory results, and commend the investigation to such as are possessed of all these requisites, with good powers of observation, and no end of patience. Ready access to specimens in the full vigour of life is also essential, and the ingenious plan of growing them on damp sand in shallow saucers might be resorted to with success, as an aid to the obtaining plenty of individuals in such condition, for purposes of study. Doubtless, after all, a good deal will depend on certain unknown conditions in the life of the plant, as there are reasons for thinking that it may be present at one of its stages, and absent at others, and favouring fortuitous circumstances may be required to render all complete, and reward the happy investigator. In addition to the brief notice of this interesting phenomenon in the introduction to the "Synopsis of British Diatomaceæ," vol. i., p. xxi., the translation from the German of a paper by Professor Max-Schultze, given in the "Quarterly Journal of Microscopical Science" for October, 1858, p. 13, should be consulted. Some of the statements of this latter observer are certainly incorrect, and a friend who has had peculiarly favourable opportunities for studying the forms mentioned, thinks others doubtful; but the subject is one of much interest, well worthy of careful attention, and promises to add some useful facts to our very scanty knowledge of the mysteries connected with LIFE.

The way in which Diatoms "increase and multiply" has yet to be spoken of. The general increase is by self-division, each frustule dividing into two—a mode of growth at first considered peculiar to, and which can be studied with unusual advantage in the tribe, but which is now known to be a very general mode of increase in vegetable cells, as also in the cells composing some of the tissues of animals. Though we are not aware that the division of the nucleus has actually been seen by any observer, there can be no doubt that such is the first stage of the process; the closeness with which it is surrounded by granules of the endochrome may, probably, account for this. Simultaneously with this, a rapid increase in the quantity of endochrome takes place, by which the two valves are pushed apart, and, in order to protect the delicate internal structures, a flinty band is formed, probably by increase of a gelatinous investment of each valve, with deposition of silex. To this protective covering of the newly-forming structures, it is unfortunate that nearly every observer has applied a different name. Pro-

fessor Smith called it "connecting membrane," an excellent descriptive term, with the one fatal objection of too great length. We shall adopt the elegant and euphonious classical word of "cingulum"—a zone, or band, since proposed for it by a later writer.

The cingulum is always in two portions, and must, from the necessities of the case, be so. This may be rendered more clear by Fig. 5.

FIG. 5.—Biddulphia aurita, in outline. *ccc*, the cingulum; two new valves, faintly indicated by dotted lines, are seen in process of formation within it.

This double character of the cingulum, with the enclosure of that portion formed in connection with the one valve by that of the other, has not hitherto been clearly pointed out. Its use as an admirable provision for protection of the newer, to whatever extent the older valves may be pushed apart, is evident, and also that the regulated access of water needful for life may be thus allowed.

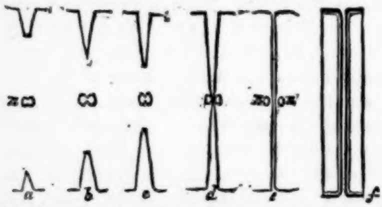


FIG. 6.—*a*, *b*, *c*, *d*, represent different stages of infolding of the primordial utricle, with division of the nucleus; at *e* this is complete, and at *f* the new valves are represented as fully formed; *n*, the nucleus.

Folding in of the primordial utricle, or lining membrane (Fig. 6), is the next step, and by it the new valves are secreted, thus completing the process.

"Multiplication by division" in this way is probably very rapid. With a due degree of patience and care an observer might watch it through all its stages, and furnish sound data for calculations on the time occupied, instead of the guesses we at present have. On the assumption that the entire process occupies in each case twenty-four hours, it has been calculated that "we should have, as the progeny of a single frustule, the amazing number of one thousand millions in a single month."*

The terms "side view" and "front view" are used to distinguish the different aspects of a frustule; the former when the valve is fully seen, as in the supposed case of looking directly down on the centre of our snuff-box; the latter, where the cingulum is seen with merely the edges of the valves, as on turning the box edgewise.

The term Diatom (from two Greek words signifying breaking or dividing into two parts) may be considered as having reference to the mode of increase by self-division, or, as suggested by Dr. Carpenter, to the readiness with which in Diatoma, one of the commonest forms, the highly siliceous frustules, held together merely by a little gelatinous hinge at the opposed corners, break up; whence the ordinary name of the family, Brittleworts.

FIG. 7.—Diatoma vulgare, in filament, represented as growing attached to a blade of grass. To show the character of the frustule the endochrome has been omitted.

The true position of the Diatomaceæ has for many years been a subject of controversy,

* Smith, "Synopsis of Br. Diatomaceæ," Introd. p. xxv.

which can here be noticed only in the briefest manner.

By Ehrenberg, one of their most distinguished investigators, they were considered to be animals, and to this opinion he still holds, ascribing to them stomachs and a series of complicated internal organs, with mouths and exsertile feet. Nearly all good observers of the present day, however, agree that erroneous interpretations have been put by this eminent Prussian naturalist on much of what he supposed he saw in them, and are unanimously of opinion that their true place is with the simpler tribes of the vegetable kingdom, in which each individual is a plant by itself, a simple cell. The strongest objection to this view—that of their independent motion—was discussed in the last chapter, and another, their apparent complexity of structure, will require after consideration. We have not been so fortunate as to meet with the arguments of those who propose to place them in a kingdom by themselves, that shall be neither animal, vegetable, nor mineral, but a combination of the attributes of all. The great point, however, on which such opinions must be based, the possession in large quantity of the mineral earth, flint, in their valves, appears to us untenable with a reasonable knowledge of the subject, derived less from books than a minute and careful study of individuals as they live and grow. This infiltration with silex is assuredly a point of minor consequence; some of the higher plants have tissues equally richly imbued with this mineral constituent; as, for instance, the external layers of cells in the sugar-cane, the bamboo, and most, if not all, of the grasses, probably some of the palms, and, lower in the scale, the horse-tails (Equisetaceæ). In addition to this argument against the proposed unnecessary separation is one still more to the point, that the amount of silex varies, according to species, indefinitely. In some it exists in such quantity as to render the valves hard and brittle as glass, *e. g.*, Pinnularia; in others it is doubtful if there be any at all, as in some of the Schizonemas, of the more delicate Nitzschiæ, and so through every gradation.

TUFFEN WEST.

THE KALEIDOSCOPIC COLOUR-TOP,

BY JOHN GORHAM, ESQ., M.R.C.S., OF TUNBRIDGE.

HAVE you not seen in the experiments with Armstrong's electric machine, at the Polytechnic Institution, a series of sparks passed along a line of insulated conductors in close proximity, which in their rapidity of passage appeared like an unbroken stream of light? The lecturer has explained that the fluid passes in distinct and separate flashes, and, by a manipulation for the purpose, has proved that such is the case. Yet, when his regiment of brass knobs is properly arranged, the sparks pass from one to the other in such rapid succession that you cannot distinguish one from another, and you see a line of light with apparently not a break in it. This is sufficient to prove that we must not depend wholly on the impressions conveyed to us by our senses, and it also proves that apparitions of objects remain on the retina of the eye after the act of real vision is at an end. Go into a factory and choose for experiment a rapidly rotating fly-wheel. When the machinery is at rest, paint the rim of the wheel with zigzag lines of blue and white, side by side, all round, very distinctly, so that there can be no question as to there being two

colours unmixed, though in close proximity. As soon as the machinery is again set in motion, look at that fly-wheel. The zigzags have vanished; there is not a line of blue or white about it, but it is painted of a uniform gray colour! No; it is as you left it, in zigzags of two colours, but by its rapid action the eye fails to detect them, and sees the two as one, and the only point of interest about it that we need now mention is, that the change has taken place in the organs of vision, not in the painting of the wheel.

Chevreul has analyzed the laws of colour with a view to point out how harmonies and contrasts are best produced, and in effecting his object he has taken occasion to explain how colours reciprocally act on each other, so as to heighten, diminish, or otherwise alter the proper effects of each when variously brought into juxtaposition. In this case, too, the changes take place in the sense of vision, not in the colours themselves. But Chevreul's experiments with strips of coloured paper, instructive as they are, do not induct us very far into the mystecious region of blended colours and harmonized tints, and we must have recourse to motion as an agency powerfully operative in effecting such modifications.

The Kaleidoscopic Colour-top, is intended for the express purpose of effecting changes in colour by motion, and promises to become most instructive to the artist and the philosopher, as well as a source of high gratification as a toy for the family circle.

What is the colour-top? Strictly it is but a coloured card made to revolve horizontally on a vertical axis; or rather, the card is an addendum to the simple apparatus whose business it is to spin when desired, and the card plays the part of the fly-wheel we just now instanced as an example of distinct colours blended into one, different from either of its components, by rapid rotation.

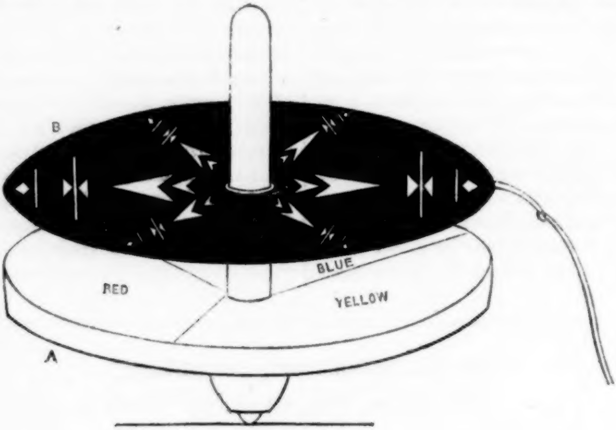


Fig. 1.

This is a mere elementary hint of what the colour-top is capable of in regard to blending of hues and colours. In the hands of the man of science it is an instrument of wonderful power, and, like a magician's shuttle, weaves as it were the rainbow itself into patterns of endless variety, in which form as well as colour plays its part in the production of extraordinary appearances.

In a description published in the pages

of the "Microscopical Journal" of January last, the following particulars are given of the simplest use of the instrument:—

Let A (Fig. 1) be a disc having the three primary colours, yellow, red, and blue, evenly distributed in sectors of 120° on its surface, and let this disc be fixed to the colour-top and rotated. Let B be a second disc, blackened on its upper surface, and having a central aperture somewhat larger than the spindle of the top, as well as a pattern of six or eight rays cut completely through and out of its substance, so that when held vertically over the disc A it will admit of the colours being seen through such pattern when viewed from above. If now the wheel is set in motion, and the disc B allowed to drop down upon the spindle of the colour-top, it will be held in contact with the spindle by centrifugal force, and will revolve in a plane parallel with the wheel, in the same direction and with the same velocity. In this case the colours on A appear mixed, while the pattern on B is effaced. But if the motion of B is retarded, and at the same time broken up into a series of rapid and regular jerks, or more properly *isochronous* vibrations, while the eye is held vertically over the spindle, each pattern is retained for an instant before the eye, yet sufficiently long to form a distinct image; and owing to the rapidity of the vibrations, a whole circle of images is thus portrayed on the retina of the eye before the image from the first vibration is effaced. In like manner, the colours of the disc A, which are perceived only as they are transmitted through the open designs in the disc B, appear in their primitive purity or unmixed state, the colour in one sector being reflected through a given ray of the pattern before the arrival of the colour from that sector by which it is immediately succeeded. Hence, both pattern and colours appear multiplied, thus producing the combinations.

FIG. 2.

From the construction of the instrument, about six revolutions of the disc A occur to

one single revolution of the disc B. When these relative velocities are maintained, five groups of all the colours distributed on the colour-disc are seen occurring in the order of their arrangement on the disc, and repeated in perfect symmetry in the various openings of the patterns. In this way the most beautiful variations may be effected by using different colours in various proportions on the disc A; for, however numerous the colours, each colour is reflected through its proper opening in the disc B, at a given interval of space and time, without the slightest irregularity or confusion. Fig. 2 represents a non-rotating disc, and Fig. 1 the same during rotation.

In order to retard the motion of the disc B, and, at the same time, to produce the vibrations, the central aperture is made sufficiently large to admit of free motion on the spindle; and there is appended, at or near its circumference, a light weight, such as a piece of string or silk, which, by its impulses on the atmosphere during rotation, both retards the motion and produces the vibrations. The proportion of the diameter of the central aperture of the disc B to that of the spindle of the colour-top is about as four to three—an aperture of four-tenths of an inch, for example, to a spindle three-tenths of an inch, is very effective.

As in the kaleidoscope, so in this instrument, there is only one position for the situation of the eye with respect to the discs where the symmetry of the combinations is perfect, namely, vertically over the spindle of the top, so that the whole of the circular field can be distinctly seen.

For the purpose of giving variety to the figures formed by the instrument, an assortment of fantastic patterns on separate discs may be constructed to take the place of the disc B; the disc A is also furnished with different colours. A disc of pure white forms exquisite gray combinations, with every conceivable variety of light and shade; a disc of white and green, in equal portions, is resolved into these elements, and their multiplication into a composite form is very agreeable to the the eye. An elegant arrangement, whereby patterns may be coloured in the most attractive manner, is composed of half a disc of blue, and the rest of white, green, and red, in equal proportions.

To the artist this instrument will prove of service in enabling him to select any number of colours in any proportion, and to adjust them instantaneously into a symmetrical pattern. He will thus be enabled to ascertain whether his selection of colours is harmonious, and he will be able to put to the test some of those beautiful harmonies which are introduced into the more recent works on colour. The following arrangement, adapted from Sir J. Gardner Wilkinson's work on Colour and Taste, will serve as an example:—

On the disc A arrange, in the following order and proportions, the colours:—Blue 129°; Scarlet, 42°; Crimson, 37°; Orange, 19°; Yellow, 52°; Green, 41°; White, 40°.

Place such a disc on the colour-top, and rotate; during rotation drop down upon the spindle any of the black perforated discs with strings appended to them: the colours of the disc A will now reappear multiplied, and presenting themselves here and there, filling up the open patterns of the perforated disc B, and forming a *polychrome* ornament, the beauty of which can scarcely be surpassed.

The pictures thus presented to the eye are very beautiful. Their charm would appear to depend partly upon their being reflected to the eye through a perfectly black medium, which imparts brilliancy and illumination to the colours, and partly upon their being exhibited in a state of motion, the *apparent* and *real* direction of which bear no relation to one another. While the disc is actually performing one hundred revolutions per minute, and vibrating about thirty times during each revolution, the combinations themselves often *appear* hanging in space,

trembling without progressing, or perfectly motionless, or gliding round in a direction contrary to that of their real motion. These frequently recurring and illusory changes excite the curiosity, give animation to the pictures, and confer an ethereal brightness, vivacity, and splendour upon them, which is altogether and peculiarly their own.

In the preparation of the discs intense washes of these pigments are chosen, and as few are required to produce an almost incalculable number of changes, the rationale of the colour-top is as simple as that of the kaleidoscope; and, in the production of colours by it, we are enabled to refer such colours to their constituents, and thus have a key to the mixing of colours for every purpose required by art. It is strange, however, that though red and yellow produce orange by rotation, and full tones and half tones result in others intermediate between them, yellow and blue, however proportioned to each other, have never yet produced even a tolerable green. This fact stands in the way at present of any attempt to form a nomenclature of colours which shall have any philosophical value. In all other respects the colour-top illustrates the laws of contrast, evokes the complementaries, and enables the operator to blend colours in softer gradations than can ever be accomplished by the pencil. Indeed, for merely visual effects, and as giving an index to the action of colours, hues, tints, and shades, upon each other, it obviates the necessity of mixing pigments until it has determined previously the nature of the mixture required for any given tone in all the range of colouring, with the strange exception of the tones of green. Let us hope that this exception may some day be found capable of explanation; at present it is a mystery.

Messrs. Smith, Beck, and Beck, 6, Coleman Street, and Messrs. Elliott Brothers, 30, Strand, are the accredited agents for this curious and instructive instrument.

WINTER MANAGEMENT OF CAGE-BIRDS.

The time has come when the best of friends must part. Our "herald of the sky" is now silent—our free denizens of the woods and forests have sung almost all their songs, and thoroughly enjoyed their holidays. They are soon about to bid us adieu for the season; many of them bound on a return-visit to a foreign land, and the remainder collecting themselves into families. All we see out of doors tells us that Summer is gone!

> "You glittering asters, with their radiant hues,
> Convey the last memorial of her reign"—

a reign that will not soon be forgotten. Yes, Summer, glorious Summer, has departed. All hail to her successor, Autumn!

> "In rosy triumph he came laughing in,
> Waving his golden hair."

And have we not, all, felt and enjoyed his magic power, delighted in his lavish bounties, and revelled in boundless luxuries of fruit and flowers—all of his own providing? Of course we have. A wee while longer he will gladden our hearts; and then—hurrah for brave, sturdy Old Winter.

Already the mornings are bright and fresh; already the air is clear and clasping. The red leaf trembles on the spray; the wind warbles and sighs among the branches of the trees. Nature is unrobing; her wardrobe is about to be laid aside. Her jewels—how simple, and yet how beautiful! Each separate article of her toilet—how artless, and yet how lovely! Oh that *we* could, all of us, take a leaf out of her ladyship's Book of Beauty. What must she think of us her children, I wonder!

This change in the season has duly

warned our winged summer visitors, that it is time to take their departure. Many—alas! too many, *are* gone. A few only remain; to collect their younger families together, and sing us a sweet parting song. All will then vanish to sunnier skies, leaving this happy thought behind them—"We shall meet again." May it be so! April will soon come round again; and the sooner the better for *us*.

We will now turn to those of our little indigenous friends, who, being part and parcel of our "happy families," claim a just right to share in the hospitalities of our festive board. Be it our pleasing duty to make them as happy and as comfortable as possible in the absence of their companions, now "birds of passage."

It is worthy of note, that by far the greatest mortality among cage-birds takes place in the autumn and winter seasons. This, be it observed, is mainly owing to the construction of their dwellings. People quite forget that birds, like themselves, require *exercise* to create and maintain warmth. This they cannot get in the small prisons usually allotted to them. Look at the cages in general use, particularly the circular ones. They are anything but spacious, open at every point to the passing wind, and perfectly murderous (at this season) as regards their inmates. This description of cage should therefore be banished at once. It is quite unsuited—nay, dangerous—for a winter residence. In summer, by all means give your birds as much air as possible—the more the better. I speak now only of the colder seasons of the year.

The best sort of winter cage for our smaller song-birds—canaries, goldfinches, linnets, etc.—is one of an oblong shape, made of mahogany, having the top, back, and sides closed, and wire open in front only. These cages, when French polished, look handsome, and can be made of any dimensions. They are by no means costly, and as they secure "Dicky's" health, comfort, and happiness, by all means open your heart-strings. Your purse-strings will open at the same time, as a matter of course.

To prevent his little majesty from being dull, let the *sides* of his cage be made to open and admit the light. This is accomplished by means of a moveable slip of transparent glass, made to run in a grove outside the wire-work. It forms a slide, and can be made a fixture or otherwise. It will be desirable to have two *wooden* moveable slides (mahogany) in addition. At night they could be used for warmth, instead of the glass slides. I call these my "model" cages.

It will be seen, by what I have said, that I regard warmth as essential to the welfare of all cage-birds in winter; this as regards both British and Foreign birds. Keep them in as equable a temperature as possible, and never leave them in a room where there has been no fire. Sudden transition from heat to cold has killed, and does kill, many a splendid songster. The lungs of birds are very delicate. How many suffering victims do I meet with, in my rambles in town and country! Here, I find them panting, wheezing, gaping; there, I see them drooping, their heads behind their wings, their feathers distended, their throats dried up, and their eyes glazed in death. All, or nearly all, arise from neglect or want of proper management.

It must be specially borne in mind, that in this country the cold weather usually sets in before birds kept in confinement have done moulting. Now the moulting season is very trying under the best of circumstances. The birds are in a high state of fever, and require more care and attention then than ever. It is a time of suffering; and, unless his feathers drop freely, there is much fear of your pet dying under the effort of Nature to give him a new dress. Warmth (but, at the same time, air) is indispensable; also, a generous diet, and much tender affection. We all know, or should know, the

value of a kind, fond nurse in the time of sickness. How we relish anything from her fair hand! We are, sometimes, positively afraid to get well *too* soon, lest the nurse should disappear together with our ailment (?).

The time required for a bird to moult properly, is ten weeks. The feathers begin to drop earlier or later, according to the heat of the weather. Keep them cheerful, give them plenty of air, and indulge them with nice, ripe, juicy salads. They will then quickly rally, recover their appetites, and pay you liberal interest in the matter of song and affection.

As regards the food of *seed*-birds—of which class I am now more particularly speaking—I would recommend a choice. Give them canary, flax, and *bird*-turnip; *not* new seed, but seed that is at least a year old, and quite sound. Much depends upon the quality of your seed whether your birds thrive well and sing well. I find *my* feathered treasures are greedily fond of grits—such as are used for gruel; they care for little else. Meal in this form, denuded of the husk, is wholesome, and it does them a world of good.

As regards cleanliness, this is at all times indispensable. Clean trays, nicely scoured, plenty of red pebbly sand, fresh water twice daily, and delicately-clean perches—these are matters of absolute necessity. Search your cages too, very closely, to see if there be any minute vermin secreted in them. If so, change the cage directly and get a new one. These "Thugs" drink up the very life's-blood of your pets' bodies. They sleep in torture, and awake in agony. Their existence becomes burthensome.

I object to the use of the bath in winter, but cannot too strongly commend it in summer. Supply it regularly every morning to *all* your birds. If any bird has his claws affected by dirt, gently immerse his feet in warm water. Drop them, between two of your partially-closed fingers, into a shallow saucer. The dirt will soon become softened by the water, and will drop off. Then tenderly dry the bird's legs and feet with a piece of soft rag, pressing lightly the while on his little body, lest his delicate machinery suffer damage from the heat of your warm hand.

"Medicine" for birds is needless—quite. If fed upon a varied diet, such as egg, macerated bread and butter, a plentiful supply of ripe, green salads, and their general food, they will never ail anything. Spread plenty of *old* bruised mortar—procurable from any dilapidated wall—on their sand. This they eat freely, and it aids their digestion. At night cover their cages over with a piece of baize. Remove it in the morning when the fire has been lighted. Always let your birds face the windows.

I have already given ample directions for taming cage-birds (see "The Key to a Bird's Heart," in RECREATIVE SCIENCE, p. 31). I hold in reserve, for future numbers, some other equally astounding secrets of Nature. Among them are some most interesting and curious facts connected with my power over wild birds in a garden, making them tame guests at the breakfast-table. I also hope to be able to explain the language of birds and other animals, and show how capable they are of becoming (as they really deserve to be) our friends and companions. Long experience in the world of Nature—my "study"—has made me quite a natural magician. I am nothing, if not surrounded by my pets. They talk to me, and I talk to them. Could I breakfast without them? No! Nor they without me! Would I part with them? Not for the universe!

Tommy Dot, Slyboots, and Scaramouch, among my birds, and Signor Snibbledibble, first and foremost among the whole race of "Wonderful Warbling Mice"—give me the society of these my amiable and loving little friends and playfellows, and *who* more happy than I?

WILLIAM KIDD.

A TRAVELLING OYSTER-BED.

There is, perhaps, no group of animals respecting which persons in general take less interest than that which comprehends the *Crustaceans*, or, in other words, crabs, lobsters, and the like, some of which are continually presented to our notice as delicacies for the table. When, indeed, the lobster, the crab, or the crayfish are dressed and served up, then attention is paid to them, and their freshness and flavour are feelingly commented upon; but here the matter ends. And yet the history of the crustacea, from those of

microscopic size, which give luminosity to the ocean, to the spine-armed giants of the waters, is replete with marvels. Manifold are the changes which many undergo from the egg to maturity; strange are the habits of others. Some are terrestrial, at least during a greater portion of the year; others semi-arboreal, climbing trees in quest of fruit; others take up their abode in the shells of sea-snails, having probably devoured the legitimate owner; while others live amidst tangled sea-weed, through the masses of which they wend their way with incredible address. Many tenant the deep clear water, amidst rocks and submerged ravines or glens; and not a few roam along the margin of the shore. Largely might we dilate upon this part of the subject, and largely upon singularities of organization, but we must here pull in the reins, our present design being merely to offer a few observations on the specimen here figured—it is an oyster-bearing crab.

Among all the crustaceans, microscopic or gigantic, the mode of growth is effected in a very peculiar manner, evincing most strikingly the wisdom of God in creation.

We know that crabs and lobsters, and all their tribe, grow. We see them of different sizes, and according to their magnitude (*cæteris paribus*) does the fishmonger charge the purchaser for them.

Now, if we look at a crab or a lobster (and the observation applies to the totality of the group, from the minutest to the most ponderous), we perceive at once that, like an armed knight of old, it is cased in complete and unyielding plates of mail, confining the limbs and body within definite limits, and which, like the rigid shoe on the foot of a Chinese lady, seem to preclude the idea of further increase; yet grow it does, and the crab, before the year is over, if left to itself in its native waters, will be found to have increased surprisingly, perhaps by a third or quarter of its original bulk and dimensions.

Here, then, are we led to inquire into the *modus operandi* by which this increase of bulk is effected.

It is by a process termed exuviation, that is, a moulting of the old shell, that liberty is given for this now naked animal to expand in all its proportions. Not only are the plates of the body thrown off, as well as those of the limbs, but the sheathing of the antennæ, fine as they may be, even of the spines and hair-

like filaments, is also cast off, together with the cornea of the eye, and the lining of the stomach, with its strong grinding teeth, which some of our readers have, no doubt, heard called "the lady in the lobster." The crustacean, now denuded, remains a soft, defenceless mass, invested merely with a thin pellicle.

Various species have their own mode of effecting this exuviation, and their own difficulties to contend with, for the operation is not in all cases very easy. Some difference in this respect may not improbably depend upon the age or condition of the individual, or upon causes beyond our present knowledge.

It is at this crisis, when the creature is soft and clad in a delicate pellicle, that its growth and general expansion take place; and this increase of bulk appears to proceed with remarkable celerity, a degree of suddenness, as if the pent-up frame, ready in its confinement for a sudden and energetic process of development, waited only the bursting of its wall of durance.

Every species, as we have said, presents us with its own mode of exuviation; for the process is definite, and not irregular or as the chance may be. The seasons also of this change are to a great extent determinate, though exuviation may be hastened or retarded by circumstances, or altogether suspended, even before the normal stature is attained. Then of course no further moult takes place, the animal having attained its maximum of development.

The armour being thus thrown off, and the soft pellicle-covered body having enlarged, the secretion of a new coat of mail from the surface of the pellicle commences and is speedily completed; the antennæ being again sheathed, the eyes fitted with new glasses, and the stomach relined and furnished with a new grinding apparatus.

It is supposed that crabs, lobsters, and crayfish undergo this change annually; but abundance of food and congeniality of temperature, or the contrary, have, undoubtedly, much influence in hastening or retarding it. We have every reason to believe that the exuviation of shrimps and prawns is very frequent, at least during the first period of their active existence, and it would appear that this is also the case with the young of crabs and lobsters, the intervals being longer as maturity approaches. Perhaps a brief account of the mode of exuviation in two species, the common lobster and crab, may be here admissible. Up to the time of its moult the lobster is active and vigorous, and contrary to what has been observed by Reaumur in the river crayfish or crawfish (which effects its freedom not without great struggles and contortions), it is agitated by no violent actions or convulsive efforts; nay, so easy is the change that fine specimens, in the hands of the fisherman, have suddenly slipped from their encasement, leaving only their shell as the reward of his labour.

It was by a circumstance of this nature that Mr. Couch was afforded the opportunity of witnessing the process and obtaining a perfect case left by the creature when it made its escape—for escape it did, to the no small annoyance of the fisherman, who was congratulating himself on a prize.

In the specimen thus obtained by Mr. Couch, the sheathing of the antennæ (horns) and complicated appendages round the mouth, the eye-stalks, and the transparent corneæ were uninjured. The segments and joints of the posterior or tail portion of the body, with the caudal or terminating plates, were all joined together, but without any intervening membrane; while the under parts from beneath the snout, including the jaws, foot-jaws, great claws, and legs, with the breastplate, gullet or œsophagus, and internal coat of the stomach, formed one connected portion. The manner in which the animal escaped was not to be mistaken. "Through the middle of the carapace (backplate) ran a line as straight as if it had been cut with a knife, and evidently formed by a natural

process of separation, for it even proceeded through the centre of the snout to the terminal pointed process, at the root of which it turned off on the right side, so that the least effort of the animal was sufficient to afford it a passage."

Preparatory to this exuviation or moult, it would appear that the flesh within the great claws is astonishingly reduced in volume and becomes very soft, parting from the thin, semi-osseous internal plate, which comes away attached to the joint of the formidable pincers so that it slips out with little difficulty.

In the river crayfish the mode of exuviation is different, and not only tedious, but, according to Reaumur, even painful.

In the common edible crab, *Cancer pagurus*, the exuviation, according to Mr. Couch (an admirable observer), takes place by a separation of the backplate, or carapace, from the under investment, the animal lying on its back during the process.

Previously to this process, as in the lobster and others, the fleshy contents of the limb-cases shrink very considerably; otherwise the flesh of the great pincers (*chelæ*), in particular, could not be extricated, for it does not appear that the shells of these *chelæ*, either in the crab or lobster, are fissured.

"The newly extricated crab, not unlike a lump of dough inclosed in membrane, has, at first, only strength enough to enable it to crawl to a place of safety—some crevice or hole. There it absorbs as much water as will distend its organs and their common covering, now as flexible as velvet, to the full extent of their capacity, by which means the deposition of the new calcareous crust is made according to the acquired bulk of the animal, which is proportionally the most increased in the youngest individuals." In the earlier stages of life, the exuviation and sudden pushing forward of growth occur several times in the course of the year, but at more distant intervals as the animal verges towards maturity.

The drawing represents the carapace, or large backplate, of a crab, covered with oysters, one or two of which are at least from four to five years old, and have there remained since the time in which they were deposited as mere dots on the spot where they have grown undisturbed, until dredged up by the fisherman. This crab was alive when we obtained it, and so were the oysters, and it was a curious sight to see the crab crawling about with its living but oppressive burden, the weight of which, on *terra firma*, or, rather, the board of the fishmonger, evidently incommoded it. On this shell five large oysters were firmly fixed, so as almost to cover the whole surface of the carapace. Yet the crab was by no means large—certainly not fully adult, its breadth across being only seven inches. Besides the oysters, there was a sandy deposit of considerable extent and elevation obscuring the head and the intervals between mollusc shells, and passing underneath their elevated edges. This sandy deposit, the particles of which were firmly agglutinated together, and which, on a *prima facie* view, resembled a sandy ant-hill, was the work of minute sea-worms, and was, in fact, a maze of burrows, which these sea-worms had constructed, and in which they dwelt, as in a populous city, and from which, when in the water, they half-extended themselves, twirling and twisting in quest of their animalcule food. The sight must have been very beautiful; but, when we obtained the specimen, though the crab and the oysters were alive, the delicate gelatinous sea-worms had all perished. Still their masonry remained to testify as to their long residence on a congenial basis.

On considering this crab attentively, the following particulars struck us. It was not full-grown, it was not developed, and yet for four or five years it had not cast its calcareous armour. This armour, or at least the backplate, was thinner than usual, and

the claws were small, in proportion, and by no means well-formed; no doubt, the oyster-shells must have impeded their free action, at least to some small extent. The colour of the carapace was paler than usual, and its texture was brittle. The contents of the encasement, that is, the body and muscles of the crab itself, were emaciated, the flesh was flabby, and, altogether it was unfit for the table; it was a very "poor crab" indeed, probably half-starved, owing to its loss of activity. Now, our inference is this, viz., that at a certain period of its existence, after acquiring a new suit of armour, the crab in question became sickly, a regular and confirmed invalid, from what cause or causes we pretend not to say; that it lurked quietly in some sick-room, but not a very secluded one, not a deep recess; and that, stirring but little, the *oyster-spat* dropped upon it, developed, grew, covered it, and at length concealed it in the oyster-bed, among a crowd, to which it belonged not, and where it was, so to speak, a stray sheep, a wanderer from its own domains. This, we know, that it was obtained by the oyster-dredger, and certainly it had no business in such a locality. Perhaps the very locality into which accident introduced it caused its sickness. How long it might have lived had not the ruthless dredger hauled it up, we cannot tell; sure, however, are we that, what with five oysters, and the sand-agglutinating sea-worms, it must have dragged on a miserable, back-burdened existence. "Call you this backing your friends?"

Now the present is not the only instance of a crustacean covered by shelled mollusca, or shell-fish, that has come under our observation. A few years since, a living, good-sized lobster was presented to us for examination, the whole backplate of which was a mussel-bed; the mussels stood upright in dense array, forming a compact phalanx, a hedgehog-back of mussels, each rooted to the spot where it had fixed itself in its primitive and imperfect condition. They were of large size, indeed of the largest, a sufficient token of their long quietude. Strange and interesting was the spectacle.

In the British Museum, and also in some of the local museums, specimens of lobsters and crabs bearing oysters and mussels, together with other burdensome parasites, are preserved as curiosities, and well worthy are they of attention. They prove that causes which we do not understand arrest the growth of crustaceans, not only in maturity, but in their earlier stages of existence, and also that this arrest of growth is by no means inconsistent with a certain degree of vital energy. In the case of the crab figured, the animal had certainly not undergone exuviation for five years, was in a sickly state, but in that of the mussel-backed lobster no appearance of sickness was observable; it was of proper weight, and thoroughly active, yet the mussel-bed must have been a fixture for at least three years. True it is that it was less incommoded by its burden than our poor crab, inasmuch as the large caudal portion (its main mass of muscles) was not incumbered, leaving it to its full liberty of movement. Strange that it should not have cast off its armour for so long a period; not more strange, however, than many other points connected with the history of the crustaceans, into which we must not now attempt to enter.

W. C. L. MARTIN.

FALLING STARS.

FALLING STARS furnish good practice to amateur astronomers for the calculation of their distances from the earth, as well as their rate of motion through space. As they are usually abundant about the middle of November, we remind our friends in good time, to enable them to prepare their minds on the subject of parallax.

THE "CONSECRATIO" COINS OF THE ROMAN EMPERORS AND THEIR FAMILIES.

IN TWO PARTS.—PART II.

At the death of Vespasian, and the ceremonials connected with the declaration of his apotheosis, a coin was struck by the senate, in deference to the wishes of his son Titus, of similar character to that issued on the death of Augustus. The car and elephants are, however, more richly executed; the leaders of the elephants are larger and more distinct, and the statue of the emperor bears on its extended hand a small figure of Victory. The inscription over the car is simply DIV. AVG. VESP., for DIVO AVGVSTO VESPASIANO. To the Divine Augustus Vespasianus. The reverse of this coin has also the large S. C., and the name and titles of Titus. It was issued A.D. 180.

Divine honours were conferred also upon empresses, and the daughters of emperors; and similar coins to those above described were issued in honour of such events. Among these I have selected for my illustration one struck by Domitian, at the consecration of his niece Julia, the daughter of Titus. In this, as in other examples of coins struck to commemorate the "consecration" of females, the inventors of the devices used in the Roman mint displayed great ingenuity; for while they strictly preserved the character of the car and statue first introduced into the Roman coinage, from the Greco-Egyptian type of the Alexandrian coin, above described, they, at the same time, succeeded in making them appropriate to a female consecration. This they effected by substituting a carpentum, or covered car, for the war chariot, or the thersa. A carpentum device was first used on a coin struck in honour of Livia, the wife of Augustus, during her lifetime. The carpentum was, in the early days of Rome, a mere covered cart, such as was used by country people, especially for females. It was generally drawn by mules, and, like all other carriages (excepting the thersa used for the statues of the gods, and the triumphal car of victors), was strictly excluded from the streets of Rome during the republic. After the establishment of the empire, the privilege of using a carpentum in the streets on public festivals was conceded to the females of the imperial house, and also to those of a few other distinguished families; and its use thenceforward became a badge of rank. It was in a carriage of this description that the statue of a deceased empress was placed to be carried to the games of the circus, instituted in honour of her consecration, and at once suggested to the designers of the types for the coinage, the idea of producing for the commemorative coins of deceased empresses an analogous device to that of the car with elephants. The coin under description, struck by Domitian to the memory of his niece, bears on the obverse a rich carpentum, the *carpentum pompaticum* of state occasions, supposed to contain the statue of the empress, though it does not appear. On arriving at the circus the statue was removed with great ceremony, and frequently placed among the statues of the gods, as a supposed witness of the games established in honour of the deceased personage which it represented. Among the flatteries accorded to Julius Cæsar, as we are informed by Dion Cassius, it was decreed by the senate that his iconic or portrait statue, sculptured in ivory, should accompany the images of the gods to the circus in a sacred chariot, and should stand

immediately opposite to that of Jupiter. In the space above the carpentum bearing the statue of Julia, on the coin engraved as below, and running round the border, is the

inscription DIVAE JULIAE AVG. DIVI TITI F., which would read at full length, DIVAE JULIAE AVGVSTAE DIVI TITI FILIAE. To the Divine Julia Augusta, Daughter of the Divine Titus. Beneath, in what is technically called the exergum of the coin, is the usual S. P. Q. R., and on the reverse there is a large S. C., the abbreviation of SENATVS CONSVLTO (by decree of the senate), surrounded by a legend, composed of the name and titles of Domitian.

A beautiful and striking variation in the consecration type is that found on the coins struck in honour of Sabina, the neglected wife of Hadrian. On the reverse of this elegant coin the figure of the empress, bearing a sceptre, is represented as being borne to the regions of the gods on the back of an eagle. Within the circuit of a floating veil are seven stars, representing a constellation, in which her spirit is about to take its abode. Beneath the figure are the letters S. C., and on the obverse a fine head of the empress, veiled, with an inscription to the effect that the coin was struck in honour of the Divine Augusta Sabina. It is thought by some that this coin was not struck by Hadrian to his long neglected wife, but that after his death, which occurred shortly after that of Sabina, it was issued by his adopted son and successor, Antoninus Pius, out of respect to the wife of his adopted father. The selection of the eagle as the spirit-bearer is consistent with its received character as the messenger of Jupiter, as the swiftest of flight among birds; in accordance with which quality it is made the bearer of the fulmen or thunderbolt, and is frequently represented at the feet of that deity, grasping the classical symbol of the thunder in both its claws. There is a fine representation of the eagle, as the bearer of a deified spirit, among the sculptures of the arch of Titus, in which the emperor is seen borne between the wings of an eagle, and crowned by a flying Victory. A precisely similar device was struck, among many others, on the "consecratio" coins issued in honour of the Empress Faustina the younger, the wife of Marcus Aurelius, which I have engraved in preference to that of Sabina, as being of better execution.

Another variety of device found upon the "consecratio" coins struck by Marcus Aurelius, in honour of his beloved but worthless wife, Faustina the younger, who, at the especial request of her bereaved husband, had been not only declared deified, but specifically declared to rank with Pallas as a virgin goddess, as though such a decree would at once refute the vulgar opinions regarding her well known profligacy. Of the coins struck in honour of the consecration of Faustina, I have next selected for illustration the one of the peacock type, engraved on next page; the spirited and bold style, both of design and execution, being very remarkable. The peacock, as being sacred to Juno, appeared to the designers of that late age, who began to get critical in the selection of their symbols,

more appropriate in connection with the consecration of an empress than the eagle, which was strictly awarded to Jupiter, and consequently more in its place in the apotheoses of new divinities of the other sex.

The legend, or inscription, is simply CONSECRATIO (the consecration) and S. C. On the obverse of the coin is the portrait of the empress, with the inscription DIVA . FAVSTINA . PIA.

The peacock is made to play a rather different, but less conspicuous part on another of the consecration coins of Faustina, with the same motto, CONSECRATIO; the device being formed of a richly decorated couch or throne, having a sceptre lying on the place to be occupied by the new divinity, and in front stands a peacock, denoting that the throne prepared for the reception of Faustina is equal to that of Juno. On another coin, with the motto AETERNITAS, the empress is seen seated on a throne, borne towards heaven by two winged female figures resembling the angels found in the mediæval pictures of the great Italian masters. Some learned numismatists have described these figures as the Hours, or as Nymphs of the air; but Tristan considers them as representing the female relations of Faustina, who had died before her, and whose spirits return to bear her to the realms they have already known. On another type the new divinity is borne aloft by a female figure bearing a torch, emblematical, perhaps, of the kindling of a new life.

The next coin I have selected for description, on account of its bearing a distinct kind of type from those described, though at a certain epoch a very general one, is also found on a coin of Faustina's. The device represented within the legend, CONSECRATIO, is that of a Rogus, or funeral pyre. Temporary structures of this kind, only erected to be consumed, were often made of the richest materials, and surrounded with niches, containing

statues of ivory, and other costly decorations, and often a number of objects, known to have been valued by the deceased. In the more costly pyres, the figure of the deceased, modelled in wax, was placed on the top of the pile, with the couch on which it had been carried, while the real remains were enclosed in a chamber near the centre of the structure, which was filled with perfumes. The nearest relative, with his face averted, set fire to the structure, while others cast into the flames cups of perfumed oil, ornaments, dishes of food, richly-woven clothes, and other things supposed to be agreeable to the deceased. On the apex of the pile, in the device under description, is a female figure in a biga, or car, drawn by two horses, doubtless a waxen effigy of the empress in her character of mother of the camps, *mater castrorum*, which she had assumed in order to acquire favour with the troops. It was customary on these occasions, just at the moment that the waxen figure melted into the flames, to release an eagle, which, taking a lofty flight, represented the escaping spirit of the material form that had just been consumed.

At a later period, when the brilliant period of the empire was past, and the arts had sunk to a very low ebb, other devices of a more simple character were adopted, as being easier to execute. These, however, if less fanciful, were, perhaps, equally poetical in their conception, and, if less picturesque,

were, perhaps, more spiritual; for, as Christianity spread, even Pagan rites gradually assumed a less materialistic aspect, which is shown in the devices, however poor in execution, which are found on the "consecratio" coins of the last emperors. On a coin struck by Maxentius to commemorate the consecration of his son Romulus, the kind of type alluded to occurs. On the reverse of this coin (engraved below) is represented a tomb with the doors partially open, as for the escape of the departing spirit, which is symbolized by an eagle on the top of the structure in the act of taking flight. No human form is carried by the eagle, as in the earlier types of the consecrative coins, but the spirit is deemed invisible, while borne aloft to the region of the gods by the bird of Jove. The inscription is AETERNAE MEMORIÆ (in eternal memory), and below, M. OST. S., which, at length, would read MONETA OSTIA SECUNDA (denoting the place where the coins were struck); for the national coinage was no longer confined exclusively to Rome, as in the more palmy days of the imperial rule, but provincial mints had been established in various districts of the empire.

A great variety of types of this last class might be described, but they are so similar in their leading characters, that little would be gained of sufficient interest to the general reader, seeking rather the recreations than technicalities of science. There are, however, certain unexplained types of similar character in our early Saxon coinage, which it might prove very interesting to investigate more fully, as they might turn out to be consecrative types imitated from those of the late Roman coinage, instead of mere "houses" or fortresses, as they have been previously described to be. A more careful examination may prove them to be representations of tombs copied from those of the late Roman coins of the "consecratio" types, and used on similar occasions; this, however, is at present mere conjecture. In conclusion, I may add that the whole series of consecrative coins of the Roman empire, from those relating to the death of the first Cæsar to those of the latest of the degenerate emperors, forms a most interesting field of examination and study, which will yield an abundant harvest of recreation as well as instruction. The numerous varieties of type issued at the consecration of Faustina the younger might alone form the subject of a very interesting essay. H. NOEL HUMPHREYS.

THE EXPANSION OF METAL,

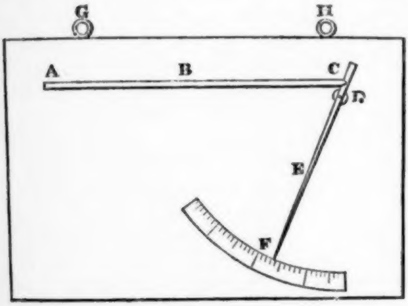
ILLUSTRATED BY EXPERIMENT.

IT is well known that heat affects the size of bodies—an increase of temperature expanding, and a decrease contracting them—and although very little is known of the nature of heat itself, some of its *effects* on bodies which come within its influence may be even rendered visible, when the amount of heat applied is far below that of what we call fire. Every one is familiar with the effect of heat in expanding a column of mercury or spirit, as in a common thermometer; but probably comparatively few have seen its effects on a bar of metal—say of copper, for instance.

The writer has for many years been in the habit of illustrating the subject by means of an original contrivance, which may

be easily comprehended by referring to the accompanying diagram.

The oblong figure represents a common slate, which may be suspended from nails in a wall by the rings G H. The bar extending from A to C is a copper wire, about one-tenth of an inch thick, *fixed* to the slate at A, but free to move in the direction of its length at C. The pointer, C F, has a notch



in it at C, on the side towards A, and moves freely on a fulcrum, D (a well-rounded piece of metal, securely fixed in the slate, to fit a small hole in the pointer, C F, at D), about one-tenth of an inch below the notch. The weight of the index keeps the wire A C (which is filed to a sharp edge at the end C to fit the notch) against the notch.

If A C be lengthened, it will obviously (A being *fixed*) cause the index C F to move upwards on the graduated arc at F. Apply a lucifer taper to the copper wire, say at B, and the index will at once move upwards. Remove it, and, as the metal cools, it will gradually fall. The experiment is a very simple one, and illustrates the subject in a very pleasing manner. The *dimensions* of the instrument may be considered as *ad libitum;* but a convenient size will be as follows:—A C = 1 foot; C D (*i. e.*, from the notch to the fulcrum) = $\frac{1}{10}$ of an inch; D F = 10 inches. For every hundredth of an inch movement of the radius C D, F will move an inch—an amount soon obtained by applying the taper as above.

The instrument is simply designed to *show* the expansion and contraction of the copper wire, not to *measure* it accurately. The one constructed by the writer is sufficiently sensible to show a difference in the length of the wire by the alteration of the temperature of the air in a room, at different periods of the year, and by a slight calculation may be made to answer the purpose of a thermometer (in some degree), although an indifferent one.

William C. Burder.

Observatory, Clifton, Bristol.

PHRENOLOGY IN THE POULTRY-YARD.

That the brain is the organ of the mind, and the ultimate means by which it is brought into relation with the material objects around us, is a fact admitted by all persons who have bestowed a thought upon the subject. Phrenologists, however, take a step in advance of this position, and map out the brain into certain regions, asserting that the different parts have distinct functions to perform; for instance, that one part is concerned in the perception of colour, a second with that of size, a third with that of form, and so on; and that the higher or reasoning faculties are situated in a distinct part of the brain from those which are concerned in the perception of external objects, and that both these pro-

tions again are separated from those that influence the lower animal propensities of eating, drinking, fighting, etc., etc. Nor do they stop here, but, proceeding still further, they assert that the size of these different parts of the brain is indicative of the power of the faculties which are exercised by them; and, therefore, that we may judge of the mental character of an individual from a consideration of the shape of his head. If these statements are true of human beings, they must be also true of the lower animals; and phrenologists speak confidently of the great development of the combative organs of the bulldog, and so on of other animals.

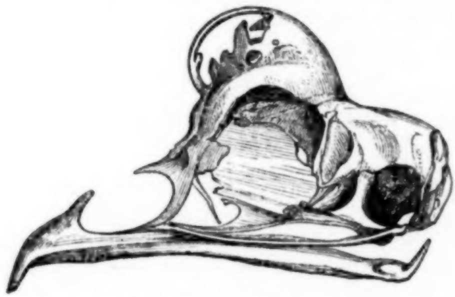


FIG. 1.—Skull of a Hen, showing spherical tuberosity.

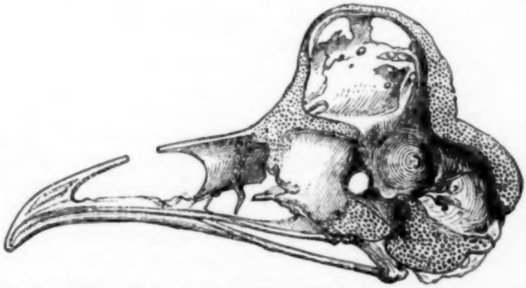


FIG. 2.—Longitudinal Vertical Section of the Skull of a Cock, showing the shape of the cavity containing the brain.

Without attempting to deny the great fundamental principles on which phrenology is based, I cannot conceal from myself the serious difficulties which are opposed to its general reception. One of the most curious of these I propose to bring before the readers of RECREATIVE SCIENCE in this paper.

Among our ordinary domesticated poultry, all of which are usually regarded as being merely varieties of the *Gallus domesticus*, there exists a breed in which the shape of the brain and the whole structure of the cranium are of the most extraordinary character. The front part of the skull is expanded into a very large protuberance, which is partly formed of bone and partly of membrane. By far the larger portion

of the brain is contained in this tuberosity, and is consequently protected from injury chiefly by the skin and feathers; the hinder parts of the brain are situated as usual in the cavity of the skull, and as the communication between the posterior cavity and that of the tuberosity is small, the brain necessarily assumes the form of an hour-glass, the front portion being, however, much larger than the hinder.

This very extraordinary structure, which is developed long before the escape of the chick from the shell, is constantly present in all the fowls of the variety. So remarkable is it, that the celebrated naturalist Pallas regarded it as being produced by a cross with the Guinea-fowl (a supposition which is alike erroneous and absurd); and in the Catalogue of the Museum of the Royal College of Surgeons, London, a very old specimen was described by one of the highest of our living scientific authorities as the result of disease, whereas the conformation exists in every fowl of the variety. Nor is it to be regarded as a recent or mere temporary freak of Nature; on the contrary, it has been persistent for centuries, and is hereditary in the race. It was noticed more than two hundred years since by the old anatomist Peter Borelli, and was described fifty years since by the celebrated Blumenbach.

That my readers may better understand the remarkable structure that I have endeavoured to describe, two engravings are given; the first being an external view of the skull of a hen of this variety, showing the large globular tuberosity, the membrane closing in the openings having been removed; the second giving a view of a section of the skull of a cock, in this the cavity containing the brain is displayed, and the peculiar shape of that organ may be inferred from it.

Now, let me ask phrenologists, what alteration in the mental character of these birds ought to result from such an extraordinary change in the form of the brain? Surely, this is not an unfair question? I, therefore, pause for a reply; and if any of my phrenological readers will say what ought to be the character of such a bird, I will next month tell them what its instincts really are, and in what manner its mental faculties are affected by its very peculiar conformation.

W. B. Tegetmeier.

AQUATIC ARCHITECTS.

Entomologists are familiar with the diving-spider, the caddis-fly, and other architects that pursue their ingenious labours under water; but it is not generally known that the larvæ of the pretty beetle *Leptura micans* passes the winter under water. I have often taken them in winter when engaged in brook-dragging, and for a time was puzzled to determine what they were. On the submerged roots of water-grasses will often be found attached small, egg-shaped, brown cocoons, nearly as large as the seeds of the smallest kidney-beans. On examining these they will be found to be the water-cases of larvæ, containing within them the partially-completed beetle in a state of torpor. As the imago of *Leptura micans* passes an aerial life, we must not look to the parent as the author of this provision for the safety of its progeny during winter. The probability is that the insect resorts to the water-side, and deposits its eggs on the leaves of aquatic plants, which in due time are hatched, and for awhile lead an aquatic life; and at last prepare for their final change to winged beetles by constructing a water-tight cocoon, within which they are ultimately developed. We know very little yet of the minute economies of insect-life, and every fact that can be added to their history introduces us to a new field of observation.

H.

METEOROLOGY OF OCTOBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1842	58·0	23·0	—
1843	66·0	25·0	—
1844	63·0	31·0	1·6
1845	66·0	31·0	1·7
1846	70·0	31·0	4·3
1847	64·5	36·0	2·4
1848	71·0	32·2	4·7
1849	69·0	27·7	3·1
1850	71·7	28·5	2·1
1851	70·0	30·0	2·1
1852	62·5	28·5	2·9
1853	65·2	27·0	3·3
1854	66·4	24·6	0·9
1855	67·9	30·0	4·7
1856	68·2	29·0	3·8
1857	71·0	31·5	2·3
1858	69·5	32·2	3·3

The greatest heat in shade reached 71·7° in 1850, and only 58·0° in 1842, giving a range in greatest heat of 13·7° for the past seventeen years.

The greatest cold was as low as 23·0° in 1842, and never below 36·0° in 1847, giving a range of 13·0°.

In 1854 only nine-tenths of an inch of rain fell in October, whilst 4·7 inches fell in October, 1848, and again in 1855, being a range of 3¾ inches. On 19th October, 1846, 1·3 inches fell, and on October 7th, 1849, an inch of rain fell. The average rain-fall in October is nearly 3 inches; it is a wet month.

E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR OCTOBER, 1859.

The sun in Libra till the 23rd, then in Scorpio.

The sun rises in London on the 1st at 6h. 1m., and on the 31st at 6h.53m. He sets on the 1st at 5h. 37m., and on the 31st at 4h. 34m.

Twilight ends on 3rd at 7h. 26m.; 31st, 6h. 28m.

Day breaks 5th, at 4h. 15m., 29th, 4h. 56m.

Length of day on the 12th, 10h. 53m., and on the 27th, 9h. 55m.; the decrease being 5h. 22m. on the 5th, and 6h. 27m. on the 24th.

Full moon on the 11th, at 11h. 51m. p.m.

New moon on the 26th, at 0h. 32m. a.m.

Moon nearest earth 22nd, furthest 6th.

Mercury very small, unfavourably situated. In Virgo at commencement, in Libra at close of the moon. In superior conjunction to the sun 11th. In conjunction with Venus on 20th, near moon on 26th.

Venus is at her greatest distance from the earth, and situated near the horizon; she is, therefore, extremely unfavourable for observation. She is in Virgo till towards the end of the month, and then in Libra.

Mars a morning star, unfavourably situated. In Leo in the beginning of the month, then in Virgo. On the 30th, at 3h. 20m. p.m. he is only two minutes west of *Eta* Virginis.

Jupiter is a fine object after midnight in the N.E. He is in Gemini at the commencement, and in Cancer at the close of the month. The following eclipses of Jupiter's satellites will be visible:—On the 4th, at 3h. 54m. a.m., the 2nd moon disappears. 6th, at 1h. 29m. a.m., the 1st moon disappears. 10th, at 1h. 40m. a.m., the 4th moon disappears. 10th, at 4h. 24m. a.m., the 4th moon reappears. 13th, at 0h. 21m. a.m., the 3rd moon reappears. 13th, at 3h. 22m. a.m., the 1st moon disappears. 20th, at 1h. 14m. a.m., the 3rd moon disappears. 20th, at 4h. 21m. a.m., the 3rd moon reappears. 20th, at 5h. 15m. a.m., the 1st moon disappears. 21st, at 11h. 44m. p.m., the 1st moon disappears. 26th, at 10h. 33m. p.m., the 4th moon reappears. 27th, at 5h. 11m. a.m., the 3rd moon disappears. 29th, at 1h. 1m. a.m., the 2nd moon disappears. 29th, at 1h. 36m. a.m., the 1st moon disappears.

Saturn is an evening star till the 29th, after which a morning star. He is in the constellation Leo. A pleasing telescopic object, although the position of his rings are not favourable for telescopic observation. He is 2° N. of the moon at 7 a.m. on the 21st.

Uranus is in the constellation Taurus, and is becoming more favourably situated for observation. He resembles a star of the 6th magnitude, and cannot be seen during moonlight.

Vesta is in Cetus, and will be brightest on the 5th (at the time of opposition). This planet, about the 7th, makes an equilateral triangle with the stars *Theta* and *Eta* Ceti. Being of the 7th magnitude, it is only just visible to the unassisted eye.

The moon is in the Pleiades near midnight on the 14th. There will be an occultation of Taygeta (5th magnitude star) on the 14th; disappearance, 11h. 43m. p.m., reappearance on the 15th, at 12h. 50m. a.m.; another of Maia on the 15th; disappearance at midnight, and reappearance at 1h. 7m. a.m.

The sun south on the 3rd, at 11h. 49m. 10s. a.m.; on the 18th, at 11h. 45m. 18s. a.m.; and on the 28th, at 11h. 43m. 56s. a.m.

Equation of time on the 1st, 10m. 13s.; on the 15th, 14m. 5s.; and on the 31st, 16m. 15s.

E. J. Lowe.

THINGS OF THE SEASON—OCTOBER.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

Birds Arriving.—Royston Crow, Common Shoveller, Dartford Warbler, Woodcock, Snipe, Wild Goose, Teal, Lesser Guillimot.

Birds Departing.—Common Marten, Sand Marten, Hobby Falcon, Short-eared Owl, Water-rail, Land-rail, Redstart, Sandpiper, Canadian Goose (rare), Ring Ousel.

Insects.—Crane Fly, Blow Fly, Water Scorpion.

Wild Plants in Flower.—Common Ivy, Genista pilosa, Purple Violet, Shepherd's Spikenard, Arbutus, Winter Green.

Mr. Noteworthy's Corner.

The Affection of Fish.—As cold-blooded as a cod, as senseless as a fish, are proverbs which go far to deny any overflow of affection to the piscine race. Those of our readers who, having aquatic vivaria, are in a position to observe the inhabitants thereof, may tell us better. Walton, copying from old Burton, tells us of several very long-lived fish, and of some which were so fond of him who fed them, that they would rise at his call. Pennant has a story of the blue shark permitting its young when attacked to take refuge by swimming down its throat; however that may be, the question of the return is the most difficult. The *descensus* is easy enough, no doubt. There is another reason against fish having affection, to which, notwithstanding the classical story of a Nubian having tamed an oyster *which followed him about like a dog* (?), we are inclined to give much weight. This is their amazing fecundity. A single child is nearly always a pet, *i.e.*, a spoilt child. A large family has very little affection wasted upon its individual members. How can any one—fish, flesh, or fowl—love 100,000 little ones at once? Yet, as has been often quoted, Leuwenhoeck found 9,000,000 eggs in a single cod; Petit 300,000 in a carp; Hamer the same number in a tench; in a mackerel 500,000; in a flounder, 1,357,000. M. Rousseau took from a sturgeon 1,567,000 eggs. Shell-fish are not so prolific; nevertheless, a lobster yielded 7,227 eggs; a prawn, 3,806; a shrimp, 3,057. This, we imagine, should settle the question of the affection of very prolific fish. Of the affection of the cetacea there can be but little doubt.

Abundance of Fungi.—In the south-eastern counties of Ireland, there has this year been an extraordinary increase in the number of mushrooms, with which the pastures have been literally whitened. On the hills, and wherever the grass is of a few years' standing, they have been so numerous that several might be found in every square yard. The people have gathered immense quantities for immediate use, and for the manufacture of catsup. In some places whole cart-loads have been seen thrown away, simply because more had been gathered than could be used. Nor have other kinds of fungi been less numerous. A very dry season was succeeded in the beginning of August by heavy rains, and the growth of fungi immediately followed. The immense abundance has never been equalled in the memory of even the "oldest inhabitant."

Naturalist's Telescope.—Mr. Noteworthy is reminded that until the opticians prepare an instrument expressly for out-door observations, much may be done with the ordinary single opera-glass, purchaseable anywhere for about 12*s.* 6*d.* Mr. Noteworthy has long had one lying in an old drawer, and until reminded of it by the letter of a reverend friend, had altogether forgotten its use and value. To see a tomtit pick the seeds from a clump of hemp plants is alone worth the cost of one of these excellent instruments.

Origin of Words.—The history of a word, like the honest history of any man or thing, will tell you much; but to know the history of many, they should be more wisely spelt. Look at the word "Admiral," for instance. What business has it with that letter "d"? Milton, no mean authority, always spells it "Amiral." Satan towers above his fellows,

"Like the mast of some tall *Amiral.*"

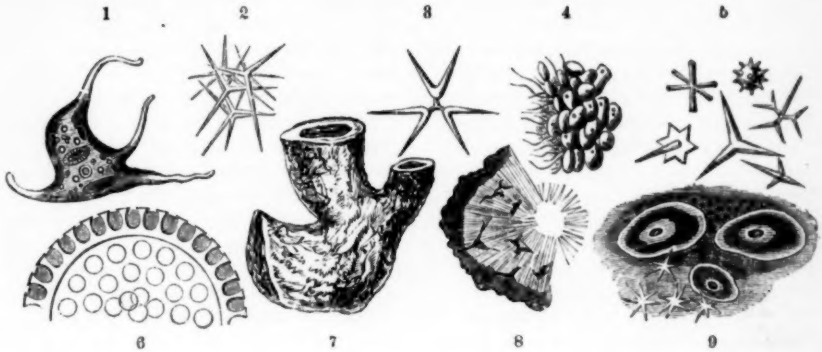
Its origin is thus given:—In opposition to the Venetian galleys used in protecting the Crusaders in the eleventh century, the Turks sent out a general governor of the fleet, an *Emir* or *Emeral.* The Venetians, in adopting the officer, took also his name. Bailey gives the derivation thus:—*Amir*, Arabic, "governor;" αλιοσ, Greek, "of the sea." Johnson says, "from the French '*Amiral*,' of uncertain etymology." The French derive it from "*Amir*," and are logical in their spelling. If so, why, we ask, do we use the *d*?

Rock-work for Fern Cases, etc.—Don't forget that pumice-stone is very light, free from pernicious ingredients, and of a suitable colour for miniature rockeries, without necessitating the trouble of washing over with Portland cement. Better still for fern cases is the petrified moss from Scarborough, Cloughton, Nidderdale, Knaresborough, etc., which you may get in quantity either at those several places or at the London shops where shells and curiosities are sold.

Appearance of a Star under the Telescope.—There is much difference between a star and a planet, as seen through a telescope. In looking at the latter the *body* is visible; in the former it is only a *concentrated light*, the *body itself* being too far away in space to be seen. In order to focus a star, the tube must be drawn out until the object is reduced to its *minimum size;* it will then be shorn of its rays, and will put on a somewhat *planetary appearance;* the smaller the telescope the less planetary will the star appear. If a telescope be not achromatic, it will not be possible to focus a star so as to free it from *false light.* In looking at a planet every additional power used increases its size, but in looking at a star the contrary (from the reason given above) takes place; the star diminishes in size, yet increases in brightness, and this diminution must go on until telescopes are constructed so large and powerful as to reduce a star to a mere point; after this any additional power would increase the size, as then the body itself would be seen.

Pistol Camera.—Mr. Skaife is reported to have invented a photographic apparatus which takes photographs instantaneously, and has been named the "Pistol Camera," from the rapidity with which "when presented," it "goes off." Is this shooting the sun, shooting the moon, or shooting the shadow?

Nature's Bountiful Provision.—We may obtain a tolerable insight into Nature's care for her children, by considering the fertility of *two* animals only, the pigeon and the rabbit. It is fairly calculated that a single pair of pigeons might produce, indirectly, in four years, 14,760 others. In the same period of time a couple of rabbits would have originated 1,274,840 bunnies.



SCIENCE ON THE SEA-SHORE.

II.—PHYSIOLOGY OF SPONGES.

Having obtained a glimpse of the important part the sponges have performed in building up the rocky fabric of the world, let us take note of a few facts of their modern history, and we shall then be better prepared to ascend a step higher in the ladder of marine zoology. It must not be supposed that remains of sponges are found only in flints; chalk also abounds with their spicules. The muddy deposits now forming round our coasts receive additions from the sponges that now people the seas; and in the white sand of the Mediterranean the remains of sponges are in regular process of deposit, and in many instances these prove to be almost identical with those found in the flints (7). On the other hand, many fossils besides those of sponges abound in flint; polypes, foraminifera, fish-scales, desmidiæ, true shells, etc., etc., are evidences of the varieties of life which abounded in the ancient seas. Now, look at this piece of sponge which I have brought with me to clean the sides of our glass vessels. It is the common sponge of commerce. At first sight, the meshes appear to be confused, but, on close inspection, we can easily detect channels passing through from the external wall to the inner side of the cup-shaped mass. Around these are numerous small pores, and the universal prevalence of these pores gives the family its scientific name of *Porifera*. We know but little as to the life of the sponge. It was at first a stretch of imagination to conceive the mass contracting and dilating, and thus causing a regular flow of water through the pores to the interior, and by the tubes again to the exterior, the food being separated for the use of the creature by the straining process. This has since been proved to be the mode of its living, the sponge proper is the frame-work or skeleton, and the gelatinous living fabric which resides in and upon it obtains nourishment in a manner similar to that of the minute ciliated creatures that we delight to watch under the microscope, churning the water and entrapping all sorts of unsuspecting creatures in their unscrupulous gullets. It was reserved

for Mr. Bowerbank to close an open question. He discovered that the sponges are provided with cilia, and thus fairly established them in the animal kingdom. He saw not only evidences of cilia, but the true hair-like processes playing with the regularity of paddle-wheels, transmitting a stream of water through the mass of the tough skeleton, and by a regular process of fishing obtaining its share of the bounties of the sea. Here is a fine boulder, half covered at this present low tide. With my bare arm I can reach down into one of its rough hollows, and with detective fingers obtain to a certainty one of the best of the sponges for microscopic observation. Here it is; a dirty-looking, funnel-shaped mass, and its name a very inviting one, "Crumb of bread," which it certainly somewhat resembles. Transferred to a small jar of fresh sea-water, wrapped round with a strip of wet flannel, and at once conveyed to the basket, it will be alive when we get home, and perhaps may live a week; and if we put on all the power we have, with a good light, we shall see the cilia imitating clock-work. In the fresh-water sponges (*Spongilla*), similar ciliatory appendages have been observed, and were admirably studied by Lieberkühn, who noticed that they disappeared with the approach of winter, indicating that probably at that season the creature ceases to feed, and becomes partially or perhaps wholly dormant.

Another good sponge, which we may obtain almost anywhere on the coast, is the "Sack," which is not so suitable to show the cilia, but the best of all to illustrate the relation of the sponges to the history of flint. Tear it up, and put a fragment under the microscope, and, wonder of wonders! see the maze of geometric forms exhibited in the bones of the creature; for who can help regarding the spicules as bones, even though a sponge be invertebrate? It is a wilderness of siliceous needles; no, not needles, pins, for every one has a knob at the base, and they cross and recross, so that the eye is bewildered to trace them out finally; and yet all is order and unity. The fingers of the Almighty Maker were not more troubled in fashioning that microscopic lace of flint than in piling up the pinnacles of the Andes. The jelly-like body of the creature permeates these spiny meshes of lime and flint, and thus, from the support it derives from them, they may truly be regarded as the bones of a boneless creation. Death dissolves the living film, but the spicules remain unhurt for a thousand years, and reveal themselves in their original sharpness and geometric accuracy of pattern to the eye of that penetrator of mysteries, the microscope (2, 3, 5).

The simplest of the Protozoa is the Rhizopoda, of which we have an easily procured type in the Amœba, a semi-transparent organization, found in ponds and infusions. They are examples of polygastric animalcules, described by Pritchard as "with one aperture only to the body, and no alimentary canal or lorica." A specimen of *Amœba radiosa* is represented in the cut at 1. It consists of a jelly-like body, capable of expansion in such a way as to manufacture for itself legs and arms, for it has no appendages whatever but such as it produces at will. Thrusting out portions of its body, it forms what are called "pseudopodia," of which the specimen represented has four. If we were to watch it one or two might be withdrawn, or one or two more extemporized, according to its own eccentric vagaries. By means of these pseudopodia it moves from place to place, and also, by a process of grasping and contracting them, it tucks into its body any morsel with which it comes into contact, and thus makes its temporary legs serve as feelers, feeders, and organs of locomotion. Strictly speaking, it has no mouth, and will as readily wrap up a grain of sand as a wandering infusorium; but a power of digestion it has, and the sand, or the rejected portions of the embraced infusoria, are expelled through some part

of the body, and thus it gets its living. Within the mass of the creature are the "many stomachs" which form the basis for the classification of the polygastrica; but they are mere vesicles surrounding a solid nucleus. The vesicles are by no means permanent; they appear and disappear according to the wants of the creature, which thus manufactures arms, legs, and stomachs as it wants them, and resolves them back into its own amorphous jelly-like body as soon as their purpose has been served. Now the physiology of a sponge may be considered to assimilate very closely to that of a rhizopod, for the gelatinous flesh consists of an agglomeration of separate bodies, each formed on the plan of an Amœba, yet acting in concert, and subsisting in one harmonious scheme of organization. At 4 is a representation of a part of the body of Grantia, one of the marine sponges, which is seen to consist of a sort of community of Amœba, with real cilia instead of pseudopodia. We can understand, therefore, how the cilia cause a current of water through the meshes of the sponge, how the particles of nourishment are seized and appropriated by the stomachs, and the rejected matters cast out with the efflux of the stream from the interior. This sponge has no net-work, and in this respect differs from the ordinary type of structure.

If we again take note of the porous system, which indeed is that which, to ordinary eyes, is all that is noticeable about sponges, we shall observe that the larger channels are few in number, but the small ones ramify through the whole mass. The larger apertures are called "oscula," and the smaller pores and the two sets of apertures are connected within by means of canals, which again connect with another set of canals, and thus constitute a true circulatory system from without by the pores to within, and from within to without by the oscula, and to the whole of these the horny, calcareous, or siliceous frame-work gives consistence and form. The passage of the current through the whole of its course may be very prettily observed under the microscope, by adding to the water in which a living specimen is placed a little finely-powdered indigo. Dr. Grant, in 1827, first revealed to the world this curious passage in the history of the sponges, to which has been added numerous additional details by more recent observers, among whom Mr. Bowerbank stands in the first rank. It should be added, as redeeming the sponge from the very low position in which we place the Amœba, that it can open and close the oscula at pleasure, and that it has the power of forming new oscula if a larger current be required. These actions have been observed by Mr. Bowerbank in the common fresh-water sponge.

The story of this wondrous life is not yet complete. The sponge can patch up any portion of its tough integuments that may suffer damage, and if two separate fragments are brought into juxtaposition, they will probably join together and become one mass as complete as if *ab initio* united. Professor Huxley has made observations on the interesting species called Tethys, which consists of a central whitish granular mass, associated with cylindrical spicula. Around this is a yellowish substance containing ova and stellate spicula. External to this is a sort of sheathing substance called the cortical layer, shown of a darker tint on the margin of the section. This cortical layer is of a deep red, deepest towards the margin, and shading off to a lighter zone inwards. The lighter portion consists of closely-woven bundles of fibrous tissue, with here and there in its substance stellate spicules, while the darker outside zone is granular, and contains great numbers of crystalline spheres beset with short conical spikes (8). Throughout the whole substance are bundles of spicula; at the centre they are somewhat regular in arrangement, but become more and more confused as they approach the cortical layer, so as to brace

the whole fabric together by a felt of spicules.

The intermediate substance is the seat of the *vital forces;* figuratively speaking, it is the heart of the sponge. It consists of circular cells and of spermatozoa in every stage of development. "The cell throws out a long filament, which becomes the tail of the spermatozoon, and becoming longer and pointed, forms, itself, the head. The perfect spermatozoa have long, pointed, somewhat triangular heads, about $\frac{1}{5000}$th of an inch in diameter, with truncated bases, from which a very long filiform tail proceeds. The ova are of various sizes; the largest are oval, and about $\frac{1}{350}$th of an inch in diameter. They have a very distinct vitellary membrane, which contains an opaque coarsely granular yolk." These details are presented at 9, where the ova may be seen embedded amongst the stellate bodies.

It should be borne in mind that the order of reproduction, so clearly explained by Professor Huxley, has been seen only in Tethys, and it is therefore only by analogy that we can predicate a similar propagation of ova in sponges generally. Lieberkühn has observed, in the fresh-water sponges, small moving corpuscles similar to the spermatozoa of Tethys, and to Carter we are indebted for drawings of the seed-like bodies occurring in *Spongilla meyeni*, of which a portion of one is represented at 6. These are a sort of leathery capsules, externally tessellated by spicula, which in section give them the appearance of toothed wheels. The capsule is filled with spherical cells containing ova, which when mature escape, through a hilum from the seed-like body, under the form of a gelatinous mass, in which certain changes begin, and the new life of the myriad germs is developed according to the order appointed them. But another mode of propagation is by what Lieberkühn calls "swarm spores," which are proverbially only the seed-like bodies in a peculiar stage of development. Be that as it may, Lieberkühn obtained swarm spores in active ciliary motion. In a few days they sank to the bottom of the vessel, where they began to adhere. They then expanded into a layer of gelatinous substance, and the characteristic flinty needles were produced, and on the twentieth day became *bona fide* and recognizable sponges. Those who are familiar with the physiology of the protozoa will find no difficulty in reconciling with this distinct spermatozoid reproduction, a system of increase by gemmules and divisions. Sponges certainly do produce bud-like offsets which become provided with cilia, and rowing away from the parent mass, establish themselves elsewhere as new colonies. The lower we descend in the ranks of both animal and vegetable life, the more numerous do we find the provisions for extension of the species. An Actinia may be cut in twain, and therefrom become two distinct creatures, each capable again of multiplication by ova; and below this low type, the possibilities of reproduction are still more varied, and evince the abundant provision of the great Architect of the whole scheme for the preservation, against all accidents and chances, of the humblest atoms of organized dust on which he has set the seal of his wisdom and power and infinite goodness.

In future papers we shall endeavour to indicate the chief points of interest discoverable in the several orders of animal life that abound upon our shores, especially taking note of those which most readily adapt themselves to the confined area of an aquarium. Those who would follow out into detail the history of the sponges will be best aided by Dr. G. Johnston's "History of British Sponges," Griffith and Henfrey's "Micrographic Dictionary," and an excellent "Manual of the Protozoa," by J. R. Greene, B.A., in "Galbraith and Haughton's Scientific Manuals."

SHIRLEY HIBBERD.

FLINTS OF THE UPPER CHALK FORMATION.

Everybody knows the appearance of flint, but few persons are acquainted with its presumed origin. If we go to the sea-side resorts of the Kentish and South-Eastern coast, we find abundant flints; if we walk on the beach, there are flints innumerable, generally small and rounded, beneath our fatigued feet; if we walk along the roads, there are flints flanking us on each side in the walls. Gathered from the pebbly beach, they are selected and split by a sharp blow, and then built up in mortar, with their split facets outwards, so as to form an enduring, though rather rough, piece of walling. Nothing could present a better exhibition of the character and contents of chalk-flints than such a wall. If a geologist had been employed to display them in the fittest manner, he could not have succeeded better than the rough wall-builder.

Suppose, however, that we enter a garden of one of the sea-side houses, and hope to find refreshment in shrubs and flowers; although the place may by courtesy be called a garden, it is after all a mere repetition of flinty specimens. There are more flints than flowers, more chalk fragments than crocuses, and more pebbles than peonies. In truth, flint, either rough or round, either monstrously large or minutely sharp, meets us in all directions. There are even flint-faced houses as well as walls; there are flints beneath our feet, on either hand, and above our head. Where did all these flints come from? That is a natural inquiry, and we shall endeavour briefly to answer it.

The Upper Chalk Formation is the original seat and source of all these masses and these rounded pebbles. Walking along the coast under the high-rising chalk cliffs, we see layers of flint lying in the chalk itself, and forming long-continued beds or seams, commonly taking the same course, the same bendings and wavings, as the chalk itself. These beds of flint may be seen at Margate, running all round by the North Foreland, and continuing to Dover. At Brighton, when we have passed Kemp Town and approach Rottingdean, two layers of flint become visible and strongly marked; and at Rottingdean itself may be seen several layers of flat flint spreading out like hard tiles through the chalk. In the Isle of Wight similar siliceous seams are visible, and at Scratchel's Bay, near the Needles, very remarkable oblique seams of flint are observable in lofty chalk cliffs. These were not deposited obliquely, but must have been originally horizontal. The fair inference, from their present oblique position, is, that they, together with the cliffs, have experienced an upheaval at one end of the range of cliffs in primeval periods, when the strata of chalk first formed horizontally were subject to great disturbance from the action of internal forces. A curious sign of the great force employed is the shattered condition of many of the flints, though still imbedded in the solid rock. The dip of the inclined strata is in general from 70° to 80°; but many of the beds, through a considerable distance, are quite vertical, and present the remarkable appearance of chalk and flints standing as it were head downwards, or much as if this page should be turned half round, and the lines of print stand upon their ends.

It is a perplexing question which we are prompted to put as we look up at vast accumulations of flint, so regular in their position, so irregular in their particular configuration: How came these hard bodies—bodies so hard that their name is a synonyme for unim-

pressiveness—how came they to lie bedded in a mass so soft as chalk? the synonyme for hardness enclosed in that for softness? Philosophers cannot answer us unhesitatingly, they can only conjecture. A common flint, the refuse of our shores, the vilest material of rough buildings, is, after all the progress of science, still a standing mystery.

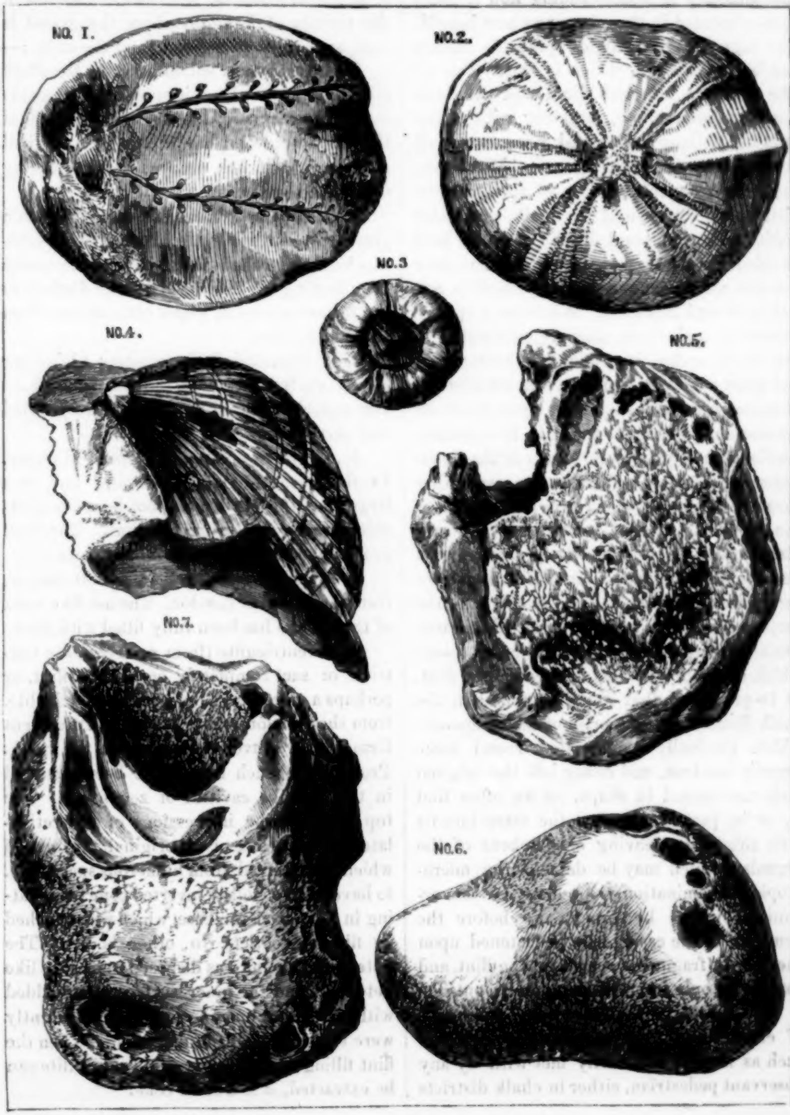
A few points are, however, well ascertained, and they are these: All these flints were once in a state of fluidity. This is proved by the fact that they contain in, or fastened upon, their own substance numerous petrified remains of sponges and animals, which we shall presently describe. These could not have become imbedded in the substance of the flint, and surrounded by it, unless the flint had once been fluid or semi-fluid. Flint, also, as we now find it, or any siliceous substance of a similar character, can be reduced again to fluid, or, as it is said, rendered soluble, when subjected to the action of caustic alkali (soda or potash) at a high temperature, in a steam-boiler or in chambers communicating with boilers. It readily fuses in a vapour heated a little above that of fused cast-iron. What is called Ransome's artificial stone is manufactured by processes of this kind. Chemists have discovered that flint, or silex, to use the technical name, is simply a compound of oxygen with a peculiar base (silicon). Silex is one of the simple materials entering into the composition of many rocks and strata, and that in so large a proportion that it is computed to form, either in a fluid or combined state, nearly one-half of the solid crust of the globe.

A remarkable present production of flint is now taking place in the siliceous deposits formed by the celebrated *geysers*, or intermittent boiling fountains, in Iceland, and on a still grander scale in New Zealand, where, from the crater of the volcanic mountain of Tongariro, upwards of 6200 feet above the level of the sea, jets of vapour and streams of boiling water highly charged with silex are continually spouting forth. After dashing down the sides of the volcano in cascades and torrents, they empty themselves into the lakes at the base. As the temperature of the water diminishes, a siliceous sinter is deposited in vast sheets, and in incrustations of flint which are thrown down upon the extraneous substances lying in the course of these thermal or warm waters. Further, silex is actually precipitated by the boiling waters in the form of stalagmitic concretions, and in nodules resembling in colour and solidity the flints of the English chalk. This has been witnessed and reported by Dr. Dieffenbach in his work on New Zealand.

The most stupendous of the boiling pools which he noticed is partly surrounded by a cliff sixty feet high, which is oxydized, corroded, and undermined from the effects of the heated vapours which are continually issuing forth in jets. At the base of this cliff the pond is constantly boiling with a white foam, and throwing up fountains eight or ten feet high with great noise and violence. The generally insoluble silex is here held in solution by the alkaline elements and very high temperature of the water. In another spot is seen a deep lake of a blue colour, surrounded by verdant hills, and in the lake are several islets, on all of which steam issues from a hundred openings between the green foliage without impairing its freshness. On the opposite side is a broad flight of steps, of the colour and aspect of white marble, with a rosy tint from siliceous incrustation, over which flows a cascade of boiling water into the lake.

On a small scale, Mr. Jeffreys has performed the same operation as that we have just described as in actual occurrence in New Zealand. That gentleman determined, by experiment, that silex is soluble in water highly heated, without the presence of alkalies or other chemical agents.

There can now be no difficulty in conceiving that silex was largely held in solution in the ancient chalk ocean, but there is consider-


NO. I.
NO.2.
NO.3
NO.4.
NO.5.
NO.6.
NO.7.

able difficulty in understanding how it could be precipitated in the manner we now behold. One ingenious and highly probable theory has been proposed, which is briefly this:—The common tuberous flints and the horizontal tabular flints, together with those forming oblique or vertical veins, were all produced by the same agency. We know, from the frequent remains of sponges now distributed throughout the chalk, that these bodies were abundant in the sea that held the chalk in solution—so abundant that their remains are almost everywhere present in certain beds and localities. Wherever a sponge settled upon shells or other organic bodies in the chalk ocean, it gradually enveloped it and grew round it more or less completely. It coated over any such mass upon which its gemmule might chance to settle, in a manner precisely analogous to the habits of the fresh-water sponge of our rivers, and to many other parasitical species which are inhabitants of the sea at the present period. As the substance thus built upon was probably, to a small extent, immersed in silt or mud, we rarely find more than half or two-thirds of the surface enveloped, and it is from this circumstance that we detect in chalk so many fossils which are, more or less, imbedded in flint. It is presumed that any flint found in the chalk formation was a mass of casing-sponge, which gradually accumulated round some organic nucleus, and either left the original body unchanged in shape, as we often find it, or in part transmuted the same into its own substance, leaving only tokens of the organism which may be detected by microscopical examination. As many of the organisms would be broken up before the gemmule of the casing-sponge fastened upon them, only fragments remain in the flint, and sometimes only impressions upon its outside.

We select, for illustration, specimens of chalk flints from our own cabinet and such as may be ordinarily met with by any observant pedestrian, either in chalk districts or in gravel districts, such as are common in the vicinity of London, where the gravel is composed of flints derived from the chalk:—

1. An echinus of solid flint, from the chalk cliffs, Margate. In this specimen the markings are particularly distinct, and it is evident that the liquid flint has filled up the original echinus, which has decayed away, leaving this interior cast of it.

2. A similar echinus, from the London gravel, Regent's Park. Although this echinus has been rolled about in its after course from leaving the chalk, yet it is as distinct as the former specimen which came at once from the flint *in situ*.

3. A beautiful little echinite (*Diadema depressa*), from a chalk flint in the road on Haverstock Hill. Flint has entirely filled and surrounded it.

4. A bivalve shell in flint, from Margate. In this case the half-enveloping flint was large, and the shell could not be made portable without fracturing the flint. The shell projected some distance from the mass.

5. A sponge enveloped in a flint casing, from the gravel of London. The net-like work of the sponge has been fully filled with silex.

6. A ventriculite (from *ventriculus*, a ventricle or sac) completely encased in flint, or perhaps a mere flint mould of the ventriculite, from the London gravel. This is a prevalent form in the gravel derived from the chalk. Probably all such flints have been moulded in the cup-like cavities of zoophytes. The top displays the impressions of the reticulated outer surface of the original, the form of which is conceived, from numerous specimens, to have been a hollow inverted cone terminating in a point at the base, which was attached by fibrous rootlets to other bodies. The outer integument was disposed in meshes like net-work, and the inner surface was studded with irregular openings, which apparently were the orifices of tubular cells. When the flint filling up the cavity of a ventriculite can be extracted, it is a solid cone.

7. Another, but imperfect, mould of a ventriculite, from the London gravel, showing the hollow interior, and on its edge a spine of an echinus (*Cidaris clavigera*) is impressed. Here then we have, as in all the other specimens, palpable proofs that the moulding or enveloping flint was originally liquid, and slowly and faithfully grew round or in the organic nucleus.

Any pedestrian who keeps his eye upon the flints and gravel laid down upon the roads around London, as near Hyde Park, Regent's Park, Hackney, etc., or even by searching the gravel path of his own garden, may find several such specimens, and reason upon them as we have reasoned in these explanatory remarks.

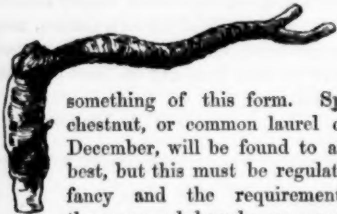
J. R. Leifchild.

BIRD-PRESERVING.

Almost the first thing a young naturalist takes interest in is what is commonly called "bird-stuffing," and with him, when he attempts it, the term is very applicable. Oh! the wretched, distorted things which rise from their collapsed state, where it had been better had they remained, "they mimicked Nature so abominably." But we must not suppress and dull the aspirations of genius, remembering that the most accomplished in any art had their beginning too. Many things are required to make anything of this art—such as delicacy of hand, great practice, but, above all, patience, the most inestimable of all common virtues. But I shall proceed to give a few plain directions, that the aspirant after taxidermal excellency may judge and try for himself, and not be disheartened. A fair specimen being obtained, take common cotton wadding, and with an ordinary paint-brush stick plug the throat, nostrils, and, in large birds, the ears, with it, so that when the skin is turned no juices may flow and spoil the feathers; you must then provide yourself with the following articles:—A knife of this kind, A, which is very common; a pair of cutting plyers, B; a pair of strong scissors, C, of a moderate size; a button-hook, D; a marrow-spoon, E; and a hand-vice, F. With these, a needle and thread, and a sharpener of some kind, to give your knife an occcasional touch, you are prepared, so far as implements go. Then provide yourself with annealed iron wire of various sizes; some you may buy ready for use, some not; but you can anneal it yourself by making it red-hot in the fire, and letting it cool in the air. Common hemp is the next article, cotton wadding, pounded

whitening, and pounded alum, or chloride of lime; as to the poisons which are used, they will be spoken of by and by. You should also have a common brad-awl or two, and some pieces of quarter-inch deal, whereon to stand the specimens when preserved, if to be placed as walking on a plane; if not, some

small pieces of twigs or small branches of trees should be kept ready for use, of various sizes according to the size of the bird;

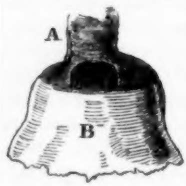


something of this form. Spanish chestnut, or common laurel cut in December, will be found to answer best, but this must be regulated by fancy and the requirements of the case; oak boughs are sometimes of a good shape.

The best time for preserving specimens is in spring, because then the cock birds are in the best feather, and the weather is not too warm. In mild weather three days is a good time to keep a bird, as then the skin will part from the flesh easily. If a specimen has bled much over the feathers, so as to damage them, wash them carefully but thoroughly with warm water and a sponge, and immediately cover them with pounded whitening, which will adhere to them. Dry it as it hangs upon them slowly before the fire, and then triturating the hardened lumps gently between the fingers, the feathers will come out almost as clean as ever. To test whether the specimen is too decomposed to skin, try the feathers about the auriculars, and just above the tail, and if they do not move you may safely proceed.

Lay the bird on his back, and, parting the feathers from the insertion of the neck to the tail, you will find in most birds a bare space. Cut the skin the whole length of this, and passing the finger under it on either side, by laying hold of one leg and bending it forward, you will be able to bring the bare knee through the opening you have made; with your scissors cut it through at the joint; pull the shank still adhering to the leg till the skin is turned back as far as it will go; denude the bone of flesh and sinew, wrap a piece of hemp round it, steeped in a strong solution of the pounded alum, and then pull the leg by the claw, by which means the skin will be brought again to its place.

After having served both legs alike, skin carefully round the back, cutting off and leaving in the tail with that into which the feathers grow, that is, the "Pope's nose." Serve the wing bones the same as the leg, cutting them off close to the body, and turn the skin inside out down to the head. The back of the skull will then appear, and you will now find it of advantage, as soon as you have got the legs and tail free, to tie a piece of string round the body, and hang it up as a butcher skins a sheep. Make in the back of the skull a cut of the annexed form, with your knife, which you can turn back like a trap-door, and with the marrow-spoon entirely



clear out the brains; A representing the neck, and B the skin turned back. Having done this, wash the interior of the skull thoroughly with the alum, and fill it with cotton wadding. The next operation requires care and practice; namely, to get out the eyes. This is done by cutting cautiously until the lids appear, being careful not to cut the eye itself, and you can then with a forceps, which you will likewise find useful, pull each from its socket; wipe the orifice carefully, wash it with the alum solution, and fill it with cotton wadding. Cut off the neck close to the skull, wash the stump, and the whole of the interior of the skin with the alum, and the *skinning* is done. Now comes the stuffing. The ordinary mode used by bird-preservers is a simple one, and answers very well; there is a French method, however, which has its advantages, and will be adverted to hereafter. Take a piece of the wire suitable to the size of the bird, that is, as large as the legs will carry, and bend it into the following form, *a* representing the neck, *b*, the body, and *c*, the

junction of the tail, allowing sufficient length of neck for the wire to pass some distance

beyond the head, and being sharpened at each end, which may be done by obliquely cutting it with the plyers. Wind upon this wire hemp to the size of the bird's body, which you should have lying by you to judge from, and it will present something of this appearance. You can shape it with the hand,

but be careful not to make it the least *too large;* and, after you have finished it to your satisfaction, you may singe it as the poulterer would singe a fowl, which will make all neat, but be particular to wind the hemp very tight. Then take the skin, lay it on the table on its back, and pass the wire at the head into the marrow where the neck is cut off, through above the roof of the mouth, and out at one nostril, and draw it up close to the skull; turn the skin back, and draw it down over the hemp body, and pass the wire spike protruding at the lower end through the flesh upon which the tail grows, about the centre, and rather below than above. The skin may now be adjusted to the hemp body, and sewn up, beginning from the top of the breast, and being particularly careful always to take the stitch from *inside,* otherwise you will draw in the feathers at every pull. At first sew it very loose, and then, with the button-hook, draw it together by degrees.

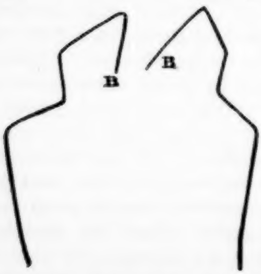
With the plyers cut two lengths of wire long enough to pass up the legs and into the neck, and leave something over to fasten the bird by to the board or spray upon which it is to be placed. The next operation requires some address and great practice, namely, the passing the wire up the legs. This is done by forcing it into the centre of the foot, and up the back of the legs into the hemp body, through it obliquely, and into the neck until it is pretty firm. In doing this, you must remember the ordinary position of a bird when alive, and, therefore, instead of passing the wire the whole way *within* the skin of the leg, when you get to the part where you have cut off the bone, that is, the knee-joint, pass it through the skin to the outside, and in again through the skin from the outside where the knee would come naturally in the attitude of standing or perching—it makes little difference which. This is essential, because if the wire be passed the whole way *inside* the skin, it produces a wrong placing of the legs. The accompanying cut will illustrate this, *a* representing the line in which the wire should run. The bird is now stuffed, and you may at once place it upon a spray, or board, as the case may be. In placing a bird upon a spray, the first joint

should be bent almost on a level with the foot; and, in placing a bird on a board, one leg should be placed somewhat behind the other. If the wings are intended to be closed, as is usually the case, bring them into their place, which may be done by putting the fingers under them, and pressing them together over the back; you may then pass a needle, or large pin, of which you should have a good supply by you, through the thick part of the upper wing into the body, and so by the lower wing, and if you

allow these to protrude, you may fasten to one of them a piece of thread, and wind it carefully and lightly round the body, which will keep the feathers in their places, and this thread should be kept on for a fortnight or three weeks, until the bird is dry. The tail should be kept in its place also for the same time, by a piece of thin wire bent over it thus:

The only thing now to do is to put in the eyes. The colour of course depends on the bird, and these you may buy at any fishing-tackle shop. If you do not use eyes too large, you will find little difficulty; the juice of the lids will act as a sufficient cement. As to the mounting, I shall say nothing about that now, but shall only advert shortly to a French method of preserving, which is more difficult, but has the advantage of superior firmness. It is this: Measuring from the insertion of the neck to the tail, make a wire frame of this form, the measure

taken being from A to B. Upon this wind hemp for the neck only, and place in the skin in the same way as before directed, only that instead of one wire being passed through that in which the tail grows, it is a fork that is passed through it. Having formed this frame, fit on to it two legs thus:



and after the frame itself is in the skin, pass these from the *inside* down each leg, instead of from the outside, and fasten them on to the frame with the plyers by twisting the ends, B B, round the frame, C, in the first figure. This will make all firm, and you can then fill the body with cut hemp, and sew up. One word as to the other preparations used by bird-preservers. These are either corrosive sublimate or regulus of arsenic, which is yellow and of a consistence like butter. As I have said before, in cold weather, when there are no flies about, alum will do perfectly well; in warm weather either of the two others may be used. I should prefer the former—corrosive sublimate—as the other is "messy," and the chief object is to dry up anything which can be attacked by flesh-seeking insects. When you have finished your bird, you can lay the feathers with a large needle—it is as well to have one fixed in a handle and kept for this purpose—and, tying the two mandibles of the bill together with a piece of thread until the whole specimen has hardened and dried, the work is done.

O. S. Round.

TELESCOPES FOR AMATEURS.

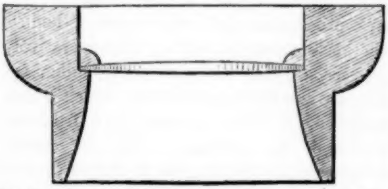
Convinced that cheap telescopes are not common enough, and that such as are manufactured are badly constructed, I venture therefore to submit the following details of the best that my brother and myself have, in five years' experimenting, managed to construct:—

Tube, of zinc at $4\frac{1}{2}d.$ per foot, so constructed that it can be used at any length, from 11 ft. 7 in. to 11 ft. 10 in. Its larger end 3 in., its smaller 2 in., in diameter.

Object-glass—double convex lens of 144 in. focus; to be had of any optician.

Eye-piece, Huygenian, formed of two plano-convex lenses, sliding in such a way that they can be arranged at any distance

between $\frac{1}{2}$ in. and $1\frac{3}{4}$ in. apart. The one near the eye must be 1 in. and the other $1\frac{1}{2}$ in. focus, with their flat sides toward the eye, and a stop of $\frac{1}{4}$ in. between them.

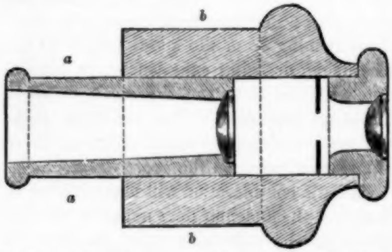


Section of Object-glass Box. External dark portion, wood; lines across centre, lenses; corners, putty.

All interiors to be blackened; the large tube can be smoked. If the small pieces of the eye-piece are turned too small, the plan used in a flute can be adopted.

Each lens should cost 1*s.* 6*d.*, the tube 4*s.* 6*d.*, and the wooden boxes for lenses 3*s.* at the utmost.

At such a price, of course, it is not achromatic; but if the tube is straight, and the object-glass stopped down to about 2 in., it will prove very effective on the Sun, Moon, Jupiter, and Saturn.



Section of Eye-piece.—*a a* slide in *b b* The black line is a stop of card-board. At the extreme right hand is the position of dark glass for viewing the sun.

A piece of a smashed negative collodion plate is a very good substitute for the black glass used before the eye-piece of telescopes when looking at the sun.

HERBERT HURST.

Upper Clapton.

DO DOGS UNDERSTAND HUMAN SPEECH?

A GENTLEMAN met with a retriever while on a shooting excursion. The dog came in obedience to a whistle, and after a little coaxing made himself quite friendly. There and then the dog adopted a master who could appreciate his noble qualities, and so they went home together.

Some few weeks after this took place, a stranger happened to be shooting in the neighbourhood, and passing near the house where the dog had taken up his abode, he was seen by the owner, who invited him in to partake of refreshments. In the course of conversation he was asked, "What sport?" "None worth speaking of," he replied; "my dog is unequal to his work. I lost one a short time since worth his weight in gold, and, unfortunately, have heard no tidings of him since." "But how and where did you lose him?" inquired the host. "Why, about fifteen miles from here, while out shooting, I missed several birds, which made me angry. I beat the dog, and threatened to shoot him. When I got into the next field 'Grouse' was gone. I thought I should find him at home; but no, he had gone utterly, and I believe he went because I threatened to shoot him." At this moment the dog entered the room. It was the lost dog, and of that there could be no doubt, but he disowned his former master. To the stranger's call he was stubbornly deaf, and when he attempted to pat him he responded with a growl that had no friendly meaning in it. The dog then crouched under the sofa, and refused to move until the object of his hatred left the room. A cord was then tied round his neck, but he planted his foot firmly, and could not be moved. His old master had no alternative but to abandon ownership, and make him a present to his host.

There is a saying that the more you beat a dog the more he'll love you; but here we

have an exception to that cruel way of gaining his affections. The dog in question had been well trained, and who can doubt his pride was wounded by the reception of unmerited blows? But did he understand the meaning of those terrible words, "I'll shoot you," and fearing the murderous threat would be executed, deem discretion the better part of valour?

MICHAEL WESTCOTT.

Wells, Somerset.

A PHILOSOPHER IN A RAILWAY TRAIN.

—o—

IT is, in every case, instructive to illustrate celestial phenomena by others within the range of terrestial existence. To those who are but slightly conversant with the more recondite facts and speculations connected with the physical sciences, this method is peculiarly useful, while from all it is worthy of regard. The phenomenon before us being well understood I need not explain it, but will proceed to show that it may be illustrated, in fact experienced, as regards mundane objects; and this in a simple manner. It would be well if all who have any knowledge of physical science would endeavour to discover some such illustrations as the one I am about to give, towards which acquisition I hope this communication will tend.

This phenomenon may be illustrated in many ways; but, as the nature of all must from necessity be similar, I shall describe only one. If any person is travelling at night in a railway carriage, on a portion of line where some branch or line meets his, and observes the lights of an approaching train on that line, they will appear to travel towards him far more perpendicularly than is really the case, because of his motion, which, for the time, he should endeavour to forget. When he reaches the junction of the lines, any particular light represents the rays emanating from any star or planet. The explanation of this is very simple: The carriage represents our earth, the rapid motion of which is not obvious to the senses; the lights on the distant railway illustrate the rays proceeding from the celestial bodies, whether obviously in motion or comparatively quiescent; these are seen approaching, apparently at no very acute angle, which is thus increased, or rather appears to be, from the motion of the carriage. They represent, then, a ray on its progress to the earth, and where the lines join, its impact upon the eye, which appears to be at a far less acute angle than reason proves to be the case. Thus it appears that the motion of the carriage produces this effect, corresponding to the delusion consequent upon the motion of the earth, which motion causes the stars to appear crowded towards the zenith. The difference in angular variation produced upon the fixed stars and planets, although full worthy of notice, does not, of course, affect this principle, and, consequently, need not here be noticed. To render the explanation more perfect, I remark that the rays proceeding from the lamps before they reach the place where the lines join, do not illustrate those coming from the stars, except as experiencing, or being experienced, in connection with the motion of the carriage; when the lamps approach the junction of the lines, the rays coming from them represent those of a star falling upon the eye.

A little consideration will make it obvious that this phenomenon does not alter the condition of the solar and lunar shadows, by which the distances of these bodies may be ascertained; yet it may be observed that the shadows always imply a lower angle than the bodies appear to make with the horizon, demonstrating the truth of the astronomical fact which I have here endeavoured to illustrate by a similar, and, as regards its nature, more intelligible, terrestrial phenomenon.

Reading. J. A. DAVIES,

WAYSIDE WEEDS AND THEIR TEACHINGS.

IN SIX HANDFULS.—HANDFUL II.

"The tribes of early flow'rets,
Like holy thoughts enshrined,
An altar to the unseen God,
They raise in every mind.
The hills and everlasting skies
In grandeur have their birth,
But the early flow'rets only
His image bring to earth."

BANKS.

—✻—

WHAT have we got? Bright yellow blossoms of broom (Fig. 23), the bonny golden broom, which every one knows, or ought to know; and equally bright and golden are those of the gorse or furze, or, as it is called in Scotland, the whin, which will make themselves seen on every common and roadside. Take these, and add to them the first of the pea or vetch tribe (Fig. 24) you meet with, throwing in a few heads of clover to make up a family party, of which the members, you quickly discover, all carry the same family face. Go on with your collecting; gather hawthorn in its season, and a crab-apple blossom or two; wild roses (Figs. 25, 26, 27) and meadow-sweet in theirs; with the flowers of the strawberry (Fig. 28) and bramble (Fig. 29). You have in your hand another family as distinct as the first. Go and secure some of those plants which you have been in the habit of calling hemlock, though ten to one if they are real hemlock; but let that pass at present—we want the kind of plant for our present purpose (Fig. 30), and, if you have no other chance, go into the kitchen-garden, and pluck a flowering sprig of celery, parsley, or carrot, or fennel, calling in, if necessary, the aid of the gardener or cook. You have now got a type of family No. 3. Lastly, the white meadow saxifrage and the willow herbs are so common that many of our readers may be able to add them to the company.

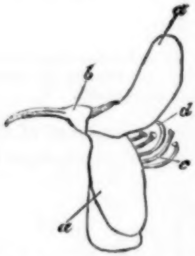


FIG. 23.—Blossom of Common Broom. *aa*, petals; *b*, calyx; *c*, stamens; *d*, pistil.

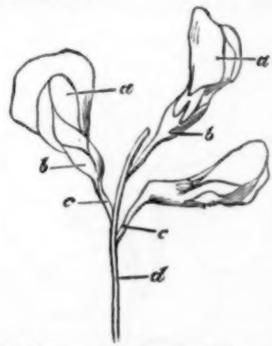


FIG. 24.—Blossoms of Common Yellow Vetchling. *a a*, petals; *b b*, calyx; *c c*, pedicels; *d*, peduncle. The flowers are papilionaceous, or butterfly-like.

The vetch tribes, represented by the broom, gorse, vetch, and clover (Figs. 28, 29), are very distinct from the rose family, to which the hawthorn, apple, strawberry (Fig. 28), and rose itself (Fig. 25) belong. Equally diverse are our hemlock friends (Fig. 30), and not less so the saxifrage and

the willow herb. Yet, pull them to pieces, they are all many-petaled, polypetalous (Fig. 31). Thus far they resemble the plants of Handful No. I., and, for aught you see

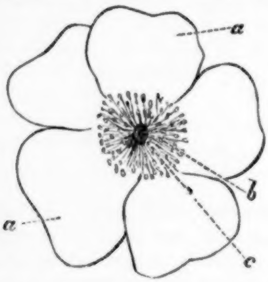


Fig. 25.—Blossom of Dog-rose. *a*, petals; *b*, stamens; *c*, pistils.

at present, might be grouped with them; but we must look further. Different as the groups of Handful II. may seem from each other, they have one common point of resem-

Fig. 26.—Back View of Blossom of Trailing Dog-rose. *a*, petals; *b*, urn-shaped tube of calyx, forming the seed-cup; *c*, upper divisions of calyx; *d*, peduncle.

blance in which they differ from Handful I., and that is in the mode in which their stamens and petals are attached to the other parts of the flower. Call to mind that in the many-petaled blossoms of Handful I. the petals and the stamens were invariably attached (Figs. 4 and 6) to the part called the

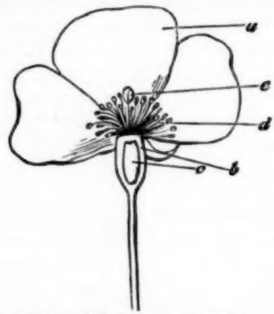


Fig. 27.—Section of Blossom of Trailing Dog-rose. *a*, petals; *b*, calyx, adhering to or forming the ovary or seed-vessel *c*; *d*, stamens; *e*, pistils.

receptacle, which formed the support of the pistil; you could detach the calyx, or, as in

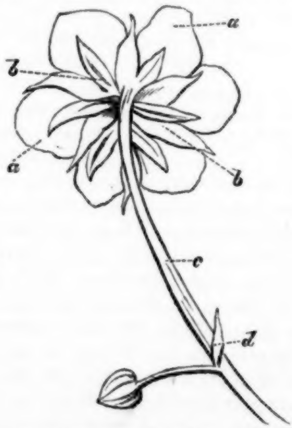


Fig. 28.—Back View of Strawberry Blossom. *a*, petals of corolla; *b*, sepals of calyx; *c*, peduncle; *d*, bract.

the poppy and in some of the ranunculus genus, it could detach itself, without interfering with the other parts of the blossom.

A very few trials with the plants we have now put into your hand will show that with them this cannot be done. If you take calyx, you take likewise stamens and petals, for to it they are attached, and not to the receptacle. All the examples you have will

FIG. 29.—Collection of Blossoms of Common Bramble, arranged in a corymb. *a*, petals; *b*, calyx sepals; *c*, stamens; *d*, pistils; *e*, pedicels; *f*, bracts; *g*, setæ or bristles; *h*, compound leaf

not show this equally well; but in some such as the strawberry (Fig. 28) and others it is very well marked. Perhaps this little difference in the attachment of the parts appears to a beginner a very little difference to say so much about; and yet, slight as seems the line of demarcation, it severs groups of plants by a strictly natural distinction, which differ widely, not only in their outward appearance, but in their medicinal and economical properties. We dwell upon it, therefore, because it teaches one of the most useful and well-marked lessons in botanical distinction which we can lay before

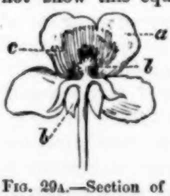


FIG. 29A.—Section of blossom of Common Bramble.

FIG. 30.—Umbels of Common Beaked Parsley, arranged in compound umbels. *a*, central point of primary umbel; *b*, bracts, or involucel, at central point of umbellule.

a beginner, and because it is one which he can so easily verify for himself by means of the commonest wayside weeds or flowers. Here, then, we have the grand distinction between Handful I. and Handful II., both made up of many-petaled plants; but in the former the petals and stamens are attached to the receptacle underneath the pistil, in the latter to the calyx.

SPENCER THOMSON, M.D.

A GEOLOGICAL SCENE IN THE ISLE OF WIGHT.

ALUM BAY AND THE NEEDLES.

EVERYBODY who has been to the Isle of Wight exclaims in enraptured terms of the beautiful scenery of Alum Bay, and in curious wonderment of those natural curiosities the "Needles." The former derives its charms from the marvellously diversified and brilliant tints of its beds of tertiary sand, rivalling the bright hues of the tulip, or the

FIG. 1.—Arch of Chalk and worn-down "Needle," in Durdle Bay.

radiant colours of striped silk; the latter are tall pinnacles of white chalk, projecting from the sea like monumental pillars, as, indeed, they are, of the waste and long-continued ravages of the sea and air.

Notorious as is the scenery throughout the island for romantic beauty, Alum Bay is admittedly superior to any other portion, for where the coloured sands end the chalk cliffs rise towering with unbroken face, their pearly hue contrasted now and then with tenderest stains of ochreous yellow and greenish vegetation, to four hundred feet in height, and terminating by a thin projection of bold and broken outline in the far-famed wedge-shape "Needles," standing out in unsullied whiteness from the blue waves.

The magical repose of one side of the bay contrasts forcibly with the rugged outline and vivid colouring of the cliffs on the other, and when, after summer rain, the sun lights up the stripes of "purplish-red and dusky blue, bright ochreous yellow, gray nearly approaching to white, and positive black," it gives an almost unearthly resplendence to the scene, which no one who has seen it ever forgets.

Such are the attractions which Alum Bay presents to the mere sight-seer; to the eye of the geologist it presents still something more. He sees all the beauty of its aspects, all the wonderful contrasts and assimilations of its variegated colours; but he sees also that which to the untutored gazer is unthought of, or a mystery; he reads in those vertical strata the ancient history of those brilliant sands, the ancient conditions of those tall white cliffs; he knows the story of those pointed pinnacles, and he revels in the rock-voiced legendary lore of the uncounted ages of the past. He, in his mental vision, sees those old chalk lands silently and solemnly rising from a former sea, bearing on their giant shoulders the thick masses of sands and muddy sediments that gather on their shores; he digs into those sands and clays which the other merely gazes at, and

exhumes the shells, and bones, and leaves, and stems of a by-gone creation, and by his labours and his reasonings raises up strange forms to our wondering sight. Not, however, from those "coloured sands" themselves does he bring us aught—the gaudy peacock is songless, the radiant humming-bird is mute, and those gay strata are fossilless. Nothing is preserved in them, so far as we yet know—and sharp eyes have looked them sharply over—of the spoils of the sea that spread them out, or of the relics of the land of which they formed the vivid fringe. But the clays on the right and on the left of them abound in fossils, and contain the bones of snakes—great coiling snakes, rivalling in strength and size the great constricting boa. Still higher (to the left), in the "Headon" beds, which, overlooking the Barton and Bracklesham clays, cap the hill on the north, some few remains of the tapir-

FIG. 2.—1, Bembridge limestone; 2, Osborne beds; 3, 4, 5, Headon beds; 5, Headon sands; 6, Middle Bagshot sands; 7, Lower Bagshot sands (coloured sands); 8, London clay; 9, Woolwich beds; *c*, chalk.

like animals which have made the quarries of Montmartre so renowned may be found. Embedded in the solid masonry of the great Pyramids of Egypt, men long since noticed coin-like objects, which they ignorantly thought to be the lentils the ancient workmen cast aside at their meals, and which in lapse of time had been petrified in the rock. These philosophers have fancifully named "money-stones," or nummulites. In truth, they are the petrified remains of pore-shelled animals of very simple grade, as low in organization as the sponges; and the "nummulite" is one of the species of a widely-spread and long-continued class, the foraminifera. In the early part of that tertiary age, in which these coloured sands and plastic clays of Alum Bay were formed into rock-beds, they swarmed in every sea, and myriads may be picked out of the "Bracklesham" and "Barton" clays immediately above our "ruddy sands" (indicated by Nos. 6 and 7 in our section, Fig. 2).*

With these last fossilless sands are commingled seams of white pipe-clay, one of which, six feet in thickness, is a natural herbarium, for, between its thin stratula, brown, dead leaves of ancient forest trees are spread by thousands, looking now, when the clay is split or cloven, like sepia drawings on white card-board. In the upper clays and sands at the foot of Headon Hill, and to the north of the "coloured sands," and in the same beds at Hordwell, on the opposite coast of Hampshire, crocodilian and mammalian remains have been also found; and the "London clay," under (south of) the same "coloured sands," may also be rich in fossil turtles, crocodiles, sharks, and sea-shells. The "Woolwich beds," formerly called by the unfitting term of "plastic clay" (for there are many other *plastic* clays), may also contain the relics of one or two species of mammals, with its innumerable fresh-water shells.

From exhumations of extinct beings, and romantic visions of ancient by-gone scenes—from such glimpses of the age of life that was before our own, the geologist reverts to those upturned beds of sands and rock, and, not content with wondering how they got so, he guages the *dip*, or inclination, and observes the bending of the beds in the regions around. Even within the limits of the island itself, he finds them curving less and less, and at last reposing nearly horizontally in their own proper places in its northern portion.

* At Alum Bay, the fossiliferous clay associated with the sands is immediately *above* them. At White-cliff Bay, it is *in* them, just below their top. In the latter case it is the equivalent of the Bracklesham clay; in the former, of the Barton clay. The Hordwell clays are still higher than the Barton and equivalent to the Headon sands.

What, then, has cast them up thus in Alum Bay?

Some time since, I was engaged in mapping out the fissures in the British Channel—for that narrow sea is but the result of fracture, from an upburst which rent a valley through the white chalk-beds that form the lofty cliffs on either side. By marking the lines of greatest sea-depth in fathoms, the lines of fracturage became easily perceptible until we got opposite to the Isle of Wight. There depths, equal to any we had found in the proper lines of cracks, seemed disposed in all sorts of ways, or, rather, one might say not disposed at all. By dint of perseverance, however, something of a star-like figure was made out, marking, to the eye of a geologist, a point of uplift or centre of disturbance. On pointing this out to a friend, I was told that a boss of granite existed in the submarine depths there; and in this, at once, we seemed to have the cause and explanation of the stratal phenomena of Alum and Freshwater Bays—the source and origin of the force or power which had cast on end the sea-girt cliffs of lovely Vectis long before the legions of imperial Rome had seen or named the pretty isle.

A few words now about the "Needles." Nature is a curious carver, and models strange things. The sea also does many remarkable things in its multiform toil; the air, with its indefatigable assistants, wind, rain, frost, and snow, produces great results by scarcely perceptible means.

Those curious pinnacles, like as the moth endured a chrysalis condition ere it assumed its winged state, have been something else before they were "Needles." What they were we see evidence of in the neighbouring coves and bays; we see also on the other side of the "narrow straits" at Etretât, Fécamp, and Dieppe.

First the sea slightly undermines the chalk-beds of the cliffs its ravages have worked into steep and narrow promontories, and then tide after tide moistens it high up with its spray.* When winter frosts set in, the icy cold seizes vitally, as one might say, on the damp rock, and with its ex_ansive

FIG. 3.—Ideal Section of Promontory of Chalk, in the first stage of waste, showing a block broken out by frost, which, on falling, will form a step or undercut.*

power splits off some fragments, which, when the thaw releases them, fall down and soon become the prey of boisterous waves, or yield

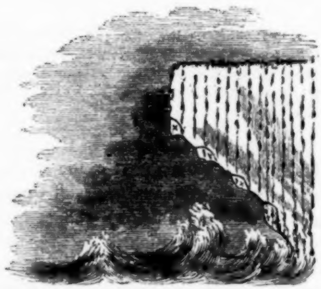


FIG. 4.—Ideal Section of Chalk Promontory, showing a series of blocks broken out by the frost.*

up their substance in tiny particles to summer's dancing ripples.

For century after century, the frost continues its periodic exercise, hurling down, year

* The boring molluscs, such as the Saxicave, may also assist in working out the *first* steps in the face of the chalk-cliffs; but the frost is the great and continuous agent.

after year, some few fresh blocks. Slowly as this is done, the principle of action remains the same, and while, year after year, portions of the first shallow roof fall in, the undermining sea is working out a second step or undercut of the chalk, and a second set of fragments falls from the powerful grasp of the frost continuously with the first; a third, fourth, fifth result, and so on by slow degrees a cave is formed, with its base the deepest indented into the side of the promontory. In the continued process of this action the cave is eaten quite through the wall of chalk, and an "arch" results, the crown of which in

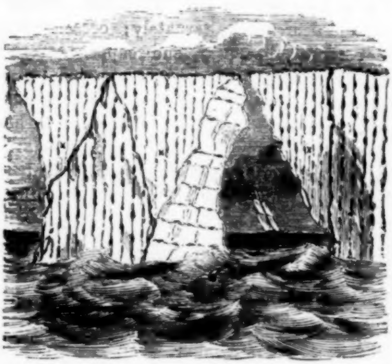


Fig. 5.—Ideal Section of Chalk Promontory, showing the crown of the arch broken through by the continued action of the frost. The faint portions indicate the parts afterwards worn away by the continuance of the same agency, until a "needle" and cliff result, as shown by the darker portions of the engraving.

like manner gradually peels away, until a vertical gap is made in the narrow headland, and a square buttress remains standing out alone from the sea. This the rain, weather, and frost sharpen by a similar, but diminished action, of peeling off the apex into a "Needle."

While this has been performing, the sea has been indenting the deep bays between the promontories of chalk, and cutting out fresh steps, or undercuts, in their steep walls; the frost has been breaking out a fresh cave further inland of the old, and in the lapse of time a second arch and a second "Needle" are produced. So on a third, a fourth, and as the like operations endure, the outermost, or first-formed "Needles" are diminished by waste to sunken rocks, become the prey of the Pholas, and are ground down by the surf into an undistinguishable portion of the great sea-bottom. So painsfully, so slowly, then, does Nature model out one, even, of her curiosities.

S. J. Mackie.

THE ETRUSCAN VASE.

Time is not supreme as a destroyer. He may deface, but not wholly obliterate the name of a people; nor, when he has crumbled their works to dust, can he finally annihilate the last faint record which shall serve as a key by which future generations shall obtain entrance to their buried archives. How many have pondered over the Etruscan vase, and how many hard-thinking and deeply-read philosophers have turned aside at last from the mystical word "Etruria," knowing not whether to declare it the name of a people, a country, an era, or a myth. But the spell is broken, and, as in the case of Egyptian and Babylonian inscriptions, an Œdipus has arisen in the person of Johann Gustav Stickel, and the Etruscan riddle has been solved. By means of the Hebrew, Tuscan relics have become intelligible, and new chapters are added to history and ethnology. Two centuries after the foundation of Rome, a colony from Judea settled in Tuscany, tilled the soil, built towns, and raised altars to other gods than the One Jehovah! These idolaters were the fathers of the modern Tuscans; the Tuscans, in fact, have descended from the Jews! Such is the conclusion of Dr. Stickel, ably set forth in his work, "Das Etruskische," lately published at Leipsic.

H.

METEORS, OR FALLING STARS.

Another recurring period of meteors, or falling stars, is now approaching, let us therefore examine in what way the amateur observer may really make himself useful, in this particular branch of science, and to do which we must give some account of the subject. So much interest is attached to these singular phenomena, and so little is as yet known concerning them, that a wide field of investigation is open before us. We are in the habit of occasionally seeing one or more of these bodies, mostly small in size, sometimes large, varying from a mere speck to above twice the size and brightness of the moon. What, then, are the kind of observations requisite, in order to make a record of those seen valuable?

The following brief summary will give, in a few words, such information that, if carefully followed and extensively persevered in, will tend much to throw the requisite light upon the subject. In the first place, the locality of observation should be recorded; and, in the second, the time as accurately as possible. It is then necessary to note the apparent size, shape, brightness, and colour of the object, and whether the meteor be accompanied by a train of separate sparks, a continuous streak of light, or destitute of such appendage; and if a streak, whether it lingers after the meteor itself has vanished. In addition to this, an estimate of the velocity and duration, direction of movement and altitude, or, what is still better, the path amongst the stars; and lastly, general remarks as to the peculiarity of appearance. The necessity of all this becomes apparent when we consider how varied are the different features. Meteors sometimes appear and vanish instantaneously, yet they have been known to remain visible above an hour. They are of every colour, and sometimes changeable, whilst others will give out sparks of a totally different colour to themselves. They move over a large or brief space in the sky, or sometimes do not move amongst the stars, and are, in fact, to all appearance *stationary*. They are circular, oval, pear-shaped, as a flame, a spark, a wisp of straw, or even quite grotesque in form. They increase in size or they become less, sometimes increasing and decreasing alternately; occasionally they appear, disappear, and reappear several times. Again, they are accompanied by a shower of stars, well-defined balls, a luminous streak, or by wavy lines. They are to be seen in every direction, and seemingly move in every direction, yet the greater number have a common origin. They explode with a noise, or no sound is audible. They occur by hundreds on some occasions, whilst at others very few, if any, are to be seen during a night's careful watch. Some on exploding hurl meteoric stones to the earth.

On certain particular days of the year meteors are more numerous than at other times, and of these the 9th and 10th of August and the 12th and 13th of November have long been noted as famous for their showers of falling stars. Another period, from the 16th to the 18th of October, is also rich in meteors.

The following periods, taken from the "British Association Records," show when meteors were more than usually abundant:*

January 26, 1844; 10 to 15, 1847; 2 and 3, 1848; 2, 1857.

* It must be recollected that unfavourable weather frequently prevents these epochs being recorded, and especially as the number of meteoric observers is very limited.

March 11 and 12, 1847; 24 and 25, 1847; 27 to 29, 1848.

April 19 and 20, 1847; 20 and 23, 1848; 27, 1848; 19 and 20, 851.

June 17 to 22, 1847; 21, 1848; 16, 1850.

July 25 to 30, 1846; 4 and 5, 1847; 22 and 23, 1847; 6, 1848; 22 to 24, 1848; 29, 1848; 20 to 23, 1849; 26 and 27, 1849; 16 and 17, 1851; 30, 1851; 28 to 31, 1856.

August 23 and 24, 1847; 21, 28, and 29, 1848.

September 15, 1846; 4, 1848; 30, 1848; 2 and 30, 1850; 9 to 12, 1852; 17 and 18, 1852; 6 and 10, 1853.

October 16, 1843; 18, 1844; 28, 30, and 31, 1845; 10, 1847; 20 to 23, 1848; 5 and 9, 1850; 16 and 17, 1851; 3, 5, and 25, 1853; 28 to 31, 1856.

November 18, 1843; 1, 1847; 5, 1848; 29, 1850; 3, 1852.

December 21, 1846; 9 and 10, 1846; 12, 1847; 11, 14, and 15, 1848.

The August and November periods (*i.e.*, 9th and 10th of August and 12th to 14th of November) are omitted in the above list as thoroughly established periods. Unfortunately a prevalence of cloud, a paucity of observers, and, lastly, the bulk of observers extending their enthusiasm only to the August and November epochs, tend much to keep other periods in the background.

We have not as yet had the good fortune to witness the sky completely covered with these fiery bodies for several hours together, yet such instances have occurred. From four to six a.m., on the 13th of November, 1833, in the United States, they fell at the rate of more than a thousand per minute, and all of them diverged from a point situated in the constellation Leo, near Regulus. This display was visible from longitude 61° in the Atlantic Ocean, to 100° in Mexico, and from the West Indies to the North American Lakes. Similar appearances took place in Cumana on the 12th of November, 1779; at Mocha on the 13th of November, 1832; on the 12th of November, 1799, at Cape Florida, Cumana, Peru, and Greenland; on the 13th of November, 1831, in Spain and on the Ohio; and vast numbers of meteors were seen on the 13th of November, 1834, 1835, 1836, and 1837, both in Europe and America.

It is supposed that certain opaque bodies are revolving through space within the limits of the solar system; some of which fall to the earth as meteoric stones. The volume of several are large, having been estimated at 75 miles in diameter, and one to have weighed 600,000 tons, and to have moved at a velocity of 72,000 miles an hour. The great meteor of the 11th of February, 1856

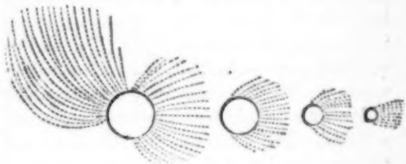


Fig. 1.

(see Fig. 1, as seen at Oxford by Mrs. Baden Powell), Mr. Glaisher calculated had a velocity of above 100,000 miles an hour. Some astronomers conceive that meteors are solid bodies, and become ignited on coming within the earth's atmosphere, owing to the great velocity with which they travel. Arago looked upon them as nebulous matter, similar to the tail of comets, and circulating round the sun in a zone that crosses the earth's orbit about the 12th of November, and that they took fire on entering the atmosphere owing to their great speed. Sir John Lubbock, on the contrary, considers them opaque bodies, which shine by the light of the sun, and are only visible whilst they pass through sunlight. In noticing the great meteor of the 19th of December, 1855 (see Figs. 2, 3, and 4, as seen at Highfield House), it appeared to me that, instead of becoming ignited, they caused, by their prodigious speed, a peculiar phosphorescent *something*

to ignite in the upper regions of the air, at the instant of ignition being intensely bright, and then subsiding into a phosphorescent flame, which streak or flame was very slowly wafted about or carried along by currents. In the case of this meteor, it moved over $18\frac{1}{2}°$ in space in less than a second of time; it cannot, therefore, be supposed that the *meteor itself* could be within 5° of this path ten minutes afterwards, although the phosphorescent light was there. Now if we suppose that the meteor burst at this point (which seems improbable), it must have burst in a medium where *light could shine*, and if so, it is as easy to suppose that some substance should be ignited by it, as that the meteor itself should blaze. The intense brightness was too great for reflected light. This meteor was first seen in the N.N.W., and moved towards the W., from near H 17 Camelopardali downwards to midway between Capella and μ Persei. The time was 6h. 13m. a.m., and the size about that of the apparent diameter of the moon; the light for the instant resembling a brilliant flash of lightning, and equalling that of day. After the meteor itself had vanished, a light similar to that of a comet's tail was visible along the whole path of the meteor; this gradually became less bright, and bent itself towards the E. Fig. 2 shows the appearance it assumed immedi-

Fig. 2.

Fig. 3.

Fig. 4.

ately after the meteor had vanished, and later (6h. 18m.) that of Fig. 3; and finally (6h. 23m.) that of Fig. 4. It was visible fully ten minutes. Somewhat analogous changes were observed in the singular meteor of September 30th, 1850, which was visible from the Cambridge Observatory, United States, and was first seen by Madame Jenny Lind, who happened to be at the Observatory at the time. Professor Bond sketched the appearance at different intervals of time. It

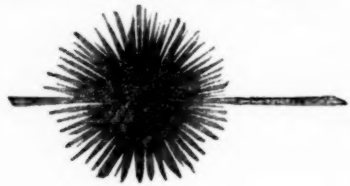


Fig. 5.

was visible an hour. Figs. 5, 6, 7, and 8 show the successive changes that it under-

Fig. 6.

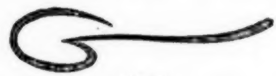


Fig. 7.

Fig. 8.

went. The height (according to the Hon. W. Mitchell) above the earth was 50 miles, and its distance from Cambridge 100 miles. (Fig. 5, at 8h. 54m. p.m.; Fig. 6, 8h. 57m.; Fig. 7, 9h. 3m.; and Fig. 8, 9h. 7m.)

The meteor of August 8th, 1849 (Fig. 9),

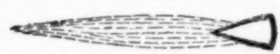


Fig. 9.

seen by myself at 10h. 16m. p.m., at the Highfield House Observatory, was kite-shaped, and left numerous separate stars in its track. The singular feature in this meteor was its disappearance and reappearance again, $1\frac{1}{2}°$ further on, after the lapse of a second

of time. Its point of disappearance was 1° below Arcturus. On its re-appearance it had become less in size, apparently moving directly away from us. Figs. 10 and 11 are

FIG. 10.

FIG. 11.

other instances of disappearing and reappearing again; the former seen at Shardlow, by Mr. W. H. Leeson, on August 15th, 1850 (9h. 35m. p.m.); the latter at Nottingham, by the late Mr. F. E. Swann, on the 14th of October, 1855 (8h. 27m. p.m.)

A remarkable meteor, A, Fig. 12, was seen by myself at Highfield House, on November 5th, 1849 (6h. 20m. p.m.) It left a thin pencil of red light in the sky throughout the whole length of its path (which was 50° in length). This pencil of light was visible five minutes, remaining as a straight line for two minutes and a half, and then changing to a wavy line, B, and in another minute

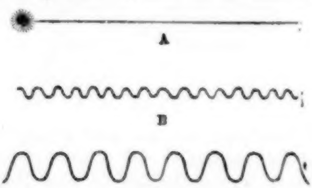


FIG. 12.

widening, as in C. The line was only as thick as a star of the first magnitude when first seen; but at last, from the apex of one wave to that of the opposite one, it was larger than the apparent diameter of the sun. It commenced disappearing from each end, the middle portion remaining visible the longest. Mr. Glaisher considers it to have been vertical over a spot fifteen miles N.E. of Montgomery, and its distance from the earth about eighty miles.

The meteor of 1851, July 4th (11h. 16m. p.m.), seen by myself at Highfield House (Fig. 13), was about twice the size of Jupiter,

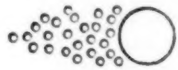


FIG. 13.

red in colour and circular in form, and was accompanied by a number of blue balls, which kept vanishing rapidly. It moved slowly, and remained visible for three seconds.

The meteor of 1851, December 1st (8h. 23m. 45s. p.m.), also seen at the Beeston Observatory, was twice the apparent size of Saturn, moved slowly, and was visible four seconds. It appeared first as a spark, then

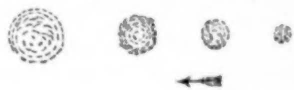


FIG. 14.

as a small number of sparks, increasing as it progressed to a great number (Fig. 14).

Fig. 15 is an instance of Aurora borealis changing the direction of a meteor. It was seen by the Rev. J. Slatter, from Rose Hill, Oxford, on the 20th of April, 1852 (11h. 25m. p.m.) On several occasions, meteors have been seen to increase in brilliancy on passing through Aurora borealis.

FIG. 15.

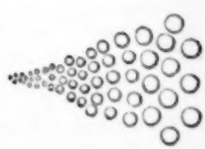


FIG. 16.

Fig. 16 is an instance of an assemblage of separate bodies becoming larger and brighter, and disappearing at the maximum brightness.

This was seen from the Beeston Observatory, on the 23rd of August, 1853 (9h. 40m. p.m.)

Fig. 17 appeared at first as large as a star of the first magnitude, shot some distance, and increased much in size; shot a

FIG. 17.

second time, and again increased; then divided into three separate portions. It was seen at St. Ives, by J. K. Watts, Esq., 25th of September, 1852 (8h. 35m. p.m.)

Fig. 18 had a beaded train, red in colour. M. F. V. Fasel witnessed this at the Stone

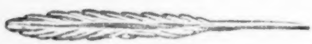
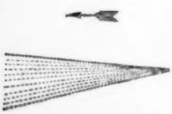


FIG. 18.

Observatory, on the 6th of September, 1852 (9h. 18m. 30s. p.m.)

Fig. 19, at first only equal to a star of the fifth magnitude (orange-scarlet), increased as separate fragments until it became at least three times the size of Saturn. Duration, two seconds. (August 29th, 1850, 10h. 3m. p.m., Highfield House.)



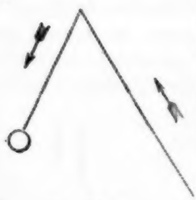


FIG. 19. FIG. 20.

On the 29th of August, 1850, at 10h. 7m. p.m., I saw, at the Highfield House Observatory, a meteor which suddenly and abruptly changed its path (Fig. 20). Another, with a curious path, was seen from the same place on the 15th of October, 1850, at 11h. 5m. p.m. (Fig. 21).

Lieut. Hardy, of Bath, observed a meteor (Fig. 22) on the 20th of June, 1851 (11h. 30m. p.m.)

FIG. 21. FIG. 22.

Mr. H. K. Watts witnessed from St. Ives a curious meteor (Fig. 23), August 25th, 1856 (10h. 46m. p.m.) It was large, red, and had a

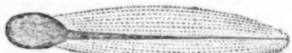


FIG. 23.

long whitish-red line running from it, emitting sparks. The same observer, on August 30th, 1854 (10h. 20m.), witnessed Fig. 24,

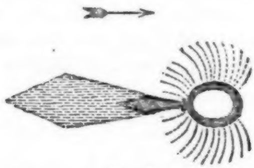


FIG. 24.

which was large, red, and had a long train of brilliant sparks.

Mr. G. F. Ansell observed near Hitchin a large fire-ball, intensely bright, which, at

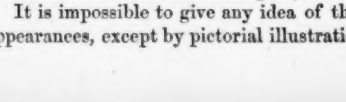


FIG. 25.

the moment of explosion, resembled Fig. 25. (October 22nd, 1854, 7h. 45m. p.m.)

It is impossible to give any idea of these appearances, except by pictorial illustration;

a few of the more remarkable have, therefore, been selected, in order to illustrate this paper.

One point requires especial notice; it is this—if the paths of a number of meteors be produced backwards, nearly all of them will meet at a certain point in the heavens, and this point, on the 10th of August of the present year, was situated midway between α and β Persei. From 11 p.m. till 3 a.m. on this night, the number of meteors seen steadily increased up to 3 a.m.; watching a fourth of the heavens gave 70 per hour, or 280 for the whole sky. Those near the above-named point had mostly very short paths, and the further they were removed from this point the longer were their paths. At 1h. 32m. it was my good fortune to see a meteor *exactly* on this point; it appeared as a mere speck, increased to that of a star of the first magnitude, and again decreased, and vanished, *without moving* in the slightest degree.

Two meteors seen at the Beeston Observatory deserve notice; the one (Fig. 26) seen

FIG. 26.

September 29th, 1857 (10h. 14m. 30s. p.m.), became very bright, and rapidly increased in size; the preceding edge was circular and well defined; but in every other direction it terminated in long streaks of light, not unlike streams of Aurora borealis. The other, seen on September 30th, 1858 (7h. 51m. p.m.), fell 1° W. along the tail of Donati's comet. It appeared, disappeared, and reappeared a score times, giving the impression of moving each time behind an opaque body.

The point from which the meteors diverge appears to be situated in Cygnus in July, whilst in August it is never far removed from Cassiopeia, and in November it is in Leo. The point of divergence seems to be the result of perspective, and that really the greater number of these bodies move in lines parallel to each other; for those in the S. and S.E. generally move to S. and S.W., whilst those to the W. and N.W. move towards W. and W.S.W. It is a singular feature that when two meteors follow each other on the same track, they invariably move at the same speed, and generally are very different in size. It might be supposed that the smaller one was an attendant or satellite of the larger one, and this very materially strengthens the opinion of their being material bodies. On the other hand, there are large meteors which move in paths discordant to the direction of meteors generally, and they alter both their shape and colour. These may be a perfectly distinct class, owing their origin to electricity, as their prevalence about the time of thunder-storms is a well-known fact.

Mr. Hind, who has observed a meteor pass slowly across the field of a large telescope, describes it as appearing better defined than a star, which it in some degree resembled; but the time was too short to allow of a planetary disc being seen. The fragments appeared like phosphoric lights.

M. Bompas has deduced the following theory, founded on observations, regarding the regular *increase* of the number of meteors through the successive hours from 6 p.m. to 6 a.m. The number which appears in the E. is above double that appearing in the W., those in N. and S. being about equal; therefore nearly two-thirds of the meteors originate in the eastern hemisphere. The greatest number is encountered when *the observer's meridian is in the direction of the earth's motion*, which is at 6 a.m., and then decreases to 6 p.m., when he looks in the opposite direction. The earth moving with

a velocity half that of the average velocity of meteors, it encounters nearly two-thirds of the number *on the side towards which* it is moving.

From M. G. von Boguslowski's observations,* it appears that the average *velocity of meteors* is about *double* that of the *earth* in its orbit.

Professor J. L. Smith shows the *fallacy* of concluding the *apparent* diameter of a highly luminous or incandescent body seen at a distance. For example, the body of electric light of carbon points, which really measured 0·3 inch in diameter, at a hundred yards' distance appeared half the diameter of the moon, at a quarter of a mile three times the moon's diameter, and at half a mile three and a half times the moon's diameter.

M. Pettit, of Toulouse, states that he has identified a meteor which is 3000 miles distant from the earth, and which revolves around our globe in 3h. 20m.

LIST OF REMARKABLE METEORS.

1830, Feb. 15	Birmingham	Dr. Hopkins	As large as the moon.
„ June 25	Gloucester	Brit. Asso. Cat.	Very large.
1832, June 23	Delhi	Brit. Asso. Cat.	Three united in one.
1833, Nov. 25	Presburg	W. W. Smyth	Brilliant, exploded, three meteoric stones found.
1837, Sept. 21	Paris	D. P. Thomson	Cast a shadow.
1839, Nov. 8	Edinburgh	D. Rankine	Twice the size of the moon.
1841, Nov. 9	Hereford	Brit. Asso. Cat.	Very large.
„ Dec. 21	Glasgow	D. P. Thomson	Twice the size of the moon.
1842, Oct. 4	Cambridge	John Glaisher	Remarkable.
1843, Feb. 5	Notts	D. P. Thomson	Blood-red mass. Velocity 55 miles per minute.
1845, April 24	Highfield House	E. J. Lowe	Large as moon. Height 90 miles.
„ June 18	Ainab	Brit. Asso. Cat.	Two connected, each five times size of moon;
„ Sept. 7	London	J. R. Hind	Large. Changed colour. [visible one hour.
„ Dec. 3	Highfield House	E. J. Lowe	Increased in brightness when crossing Aurora.
1846, Mar. 21	Toulouse	M. Pettit	Large. Inferred to be a satellite to the earth.
„ Mar. 22	Bagnères	M. Pettit	Set fire to a building.
„ June 3	Moreton Bay	D. C. M'Connell	Like the moon. Exploded as a cannon.
„ June 20	Marieux	D. P. Thomson	Gave off five balls, each quarter size of original.
„ June 29	Parma	M. Colla	Large.
„ July 14	Braunau	W. W. Smyth	Violent explosions. Meteorite fell.
„ July 23	Toulouse	M. Pettit	Large. Inferred to be satellite to the earth.
„ July 25	Gloucester	Brit. Asso. Cat.	Large.
„ Sept. 10	Highfield House	E. J. Lowe	Increased in brightness crossing Aurora.
„ Sept. 25	Highfield House	E. J. Lowe	Large.
„ Oct. 9	Paris	M. Cadart	Large.
„ Nov. 9	Dijon	M. Melline	Two. Large.
„ Dec. 21	Parma	M. Colla	Remarkable bolide. Day-time.
1847, June 21	Highfield House	E. J. Lowe	Increased in brightness when crossing Aurora.
„ Sept. 7	Bombay	Brit. Asso. Cat.	Large. *Blue*, and on bursting *red*.
„ Nov. 19	Oxford	— Symonds	Large. Twice stationary for seven minutes.
1848, Feb. 2	Wrenbury	D. P. Thomson	Large. *Green* with *crimson* border.
„ Feb. 20	Highfield House	E. J. Lowe	Increased in brilliancy when crossing Aurora.
„ Sept. 4	Ventnor	Mrs. Dixon	Large as moon.
„ Mar. 8	Slough	Mrs. Atkin	Larger than moon. Kite-shaped.
„ July 13	Stone Easton	Henry Lawson	Large. Cream colour, sparks red and green.
„ Sept. 4	Highfield House	E. J. Lowe	Large. Straw colour, changing to purple.
„ Nov. 9	Highfield House	E. J. Lowe	Large.
„ Nov. 15	Aix-la-Chapelle	M. E. Heis	Large as moon.

* "Recherches sur les Etoiles Filantes."

848, Nov. 21	Oxford	J. Slatter	Four fell into an Aurora, and disappeared.
1849, Mar. 6	London	W. H. Black	Large. White, afterwards greenish-red.
„ Mar. 19	Bombay	Brit. Asso. Cat.	Large. Green, red sparks.
„ Mar. 26	Cochin	Brit. Asso. Cat.	Large. Green, red tail.
„ April 30	London	F. Barnard	Divided into two. Daylight.
„ July 12	Highfield House	E. J. Lowe	Quarter the size of moon. Blue, red sparks.
„ Aug. 8	Highfield House	E. J. Lowe	Kite-shaped. Disappeared and reappeared.
„ April 13	Poona	Brit. Asso. Cat.	Large.
„ Nov. 2	Highfield House	E. J. Lowe	Large. Orange-red.
„ Nov. 5	Highfield House	E. J. Lowe	Leaving a wavy streak. Height 80 miles.
„ Nov. 7	Mazagon	Brit. Asso. Cat.	Large.
„ Nov. 9	Asseerghur	Brit. Asso. Cat.	Bright as moon. Loud explosion.
„ Nov. 17	Swansea	— Hill	Large.
„ Dec. 4	Highfield House	F. E. Swann	Large. Orange-red.
„ Dec. 19	Edinburgh	J. D. Forbes	Large.
„ Dec. 30	Hartwell	C. Lowndes	Large.
1850, Feb. 5	Sandwich	W. H. Weekes	Stationary $1\frac{3}{4}$ min., exploded, and moved on.
„ Feb. 7	At sea	Brit. Asso. Cat.	Large as moon.
„ Feb. 11	PenzancetoDur-[ham	John Glaisher	Large as moon. (See account.)
„ Feb. 20	London	J. Wallis	Very large.
„ June 6	Havre	Brit. Asso. Cat.	Large as moon.
„ July 4	Beeston	E. J. Lowe	Large.
„ July 5	Grantham	J. W. Jeans	Large. Exploded over Boston.
„ July 14	Grantham	J. W. Jeans	Large.
„ Aug. 10	Tipperary	Brit. Asso. Cat.	Large as moon. Red, then blue.
„ Aug. 12	Penzance	R. Edmonds	Bright as moon.
„ Aug. 14	Beeston	R. Enfield	Large.
„ Aug. 15	Shardlow	W. H. Leeson	Large. Disappeared and reappeared.
„ Sept. 30	Leven	W. Swan	Pear-shaped. Large.
„ Oct. 9	Hereford	C. Lingen	Large.
„ Nov. 6	Bombay	Dr. Buist	Large. Streak visible 20 minutes.
„ Nov. 28	Highfield House	A. S. H. Lowe	Large.
„ Nov. 29	London	J. R. Hind	Large. Stationary for a time.
1851, Jan. 8	Beerbhom	Dr. Buist	Large. Sunshine.
„ April 27	Durham	Prof. Chevallier	Large.
„ May 22	Ennore	Dr. Buist	Large. Purple and green.
„ June 1	Calcutta	Dr. Buist	Large.
„ June 20	Bath	Lieut. Hardy	Large.
„ June 22	Belfast	J. Cameron	Nearly as large as moon.
„ Sept. 2	Huggate	T. Rankin	Large.
„ Sept. 19	Calcutta	Dr. Buist	Large.
„ Sept. 20	Highfield House	A. S. H. Lowe	Large.
„ Sept. 25	Bombay	Dr. Buist	Large. During a storm.
„ Oct. 17	Stone	M. F. V. Fasel	A meteor parted into two.
„ Nov. 3	Highfield House	E. J. Lowe	Large. Orange, then blue; stationary at first.
„ Nov. 4	Bramcote	R. Enfield	Large. Prismatic.
„ Nov. 11	Cast. Donington	W. H. Leeson	Curious.
„ Nov. 16	Highfield House	E. J. Lowe	Curious.
„ Dec. 1	Obs., Beeston	E. J. Lowe	Curious.
1852, April 20	Oxford	J. Slatter	Curious. Repulsed by Aurora.
„ July 3	Dreux	M. J. E. Durand	Large.
„ July 12	Dunse	W. Stevenson	Nearly as large as moon.
„ July 13	London	J. C. Moore	Large. Changed colour.
„ Aug. 22	St. Ives	J. K. Watts	Very large.
„ Sept. 24	Stone	M. F. V. Fasel	Large. A splash of flame.
„ Sept. 25	St. Ives	J. K. Watts	Large and curious.

1852, Dec. 17	Dover	F. Higginson	Half size of moon, hissing, fell in sea, causing [spray.
1853, Aug. 7	Glasgow	D. Rankine	Large.
„ Aug. 9	London	W. R. Birt	Separated into two.
„ Aug. 23	Highfield House	E. J. Lowe	Curious.
„ Sept. 25	Stone	M. F. V. Fasel	Curious wavy train.
„ Sept. 30	Leven	W. Swan	Large. Pear-shaped.
„ Oct. 28	Obs., Beeston	Mrs. E. J. Lowe	Half the size of sun. Day-time.
1854, Feb. 25	Obs., Beeston	E. J. Lowe	Disappeared on reaching zodiacal light.
„ April 1	Obs., Beeston	S. Watson	Very large.
„ Aug. 30	St. Ives	J. K. Watts	Large and curious.
„ Oct. 7	Nottingham	F. E. Swan	Large.
„ Oct. 22	Hitchin	G. F. Ansell	Large.
1855, July 13	Beeston	E. J. Lowe	Large.
„ Aug. 3	Beeston	E. J. Lowe	Large.
„ Aug. 10	Beeston	E. J. Lowe	Curious.
„ Oct. 14	Nottingham	F. E. Swan	Large. A break in the tail.
„ Dec. 11	Edinburgh	C. P. Smyth	Large.
„ Dec. 19	Highfield House	E. J. Lowe	Large as moon. Visible ten minutes.
1856, Jan. 7	Rosehill	M. Carrington	Nearly as large as moon. [red.
„ Feb. 3	Obs., Beeston	E. J. Lowe	Half size of moon. Green, then orange, then
„ Aug. 25	St. Ives	J. K. Watts	Curious.
„ Aug. 31	Highfield House	E. J. Lowe	Curious.
„ Oct. 27	St. Ives	J. K. Watts	Curious.
„ Dec. 13	Highfield House	E. J. Lowe	Large and curious.
1857, Jan. 9	Ashford	F. Wakefield	Large.
„ Apr. 16	Highfield House	A. S. H. Lowe	Large.
„ Sept. 29	Highfield House	E. J. Lowe	Large and curious.
1858, Sept. 30	Obs., Beeston	E. J. Lowe	Curious.
1859, Aug. 10	Obs., Beeston	E. J. Lowe	Curious.

A lengthened description of the whole of the above meteors is included in the Rev. Professor Baden Powell's Reports on "Luminous Meteors," published in the "British Association Transactions," 1848—1859.

One other phenomenon deserves notice. In 1845 M. de Gasperis and Sig. Capocci, on the 11th of May, witnessed a great number of black bodies cross the sun's disc. In 1849 Mr. Brown, of Deal, on the 5th of February, saw two. Other observers have witnessed the same phenomenon, and Messier,* in 1777, saw 200 dark bodies cross the solar disc. Mr. Dawes conceives the appearance to be due to seeds floating in the atmosphere, whilst the Rev. W. Reed disputes Mr. Dawes's notion. To say the least, the subject is worth a few years' careful attention. It must, however, be borne in mind that, in all probability, they are within a few thousand, perhaps hundreds, of miles' distance; therefore a telescope will require focussing expressly for this purpose, as the focus of the sun, for instance, would perhaps allow the bodies to pass across the disc without being seen. Professor Erman* has stated that the cold days of the 5th to the 7th of February, and the 11th to the 13th of May, were owing to the passage of falling stars between us and the sun.

E. J. Lowe.

Highfield House Observatory.

* "Observation singulier d'une prodigieuse quantité de petites globules qui ont passé au devant du disque du soleil."—*Mem. Acad. Paris*, 1777, p. 464.

* "Astronomische Nachrichten," No. 385.

A WILD PRIMROSE

Was seen in bloom, October 10th, on Lesser Cumbrae, Firth of Clyde, lat. 55½° N., where the gulf-stream promotes a very equable temperature.

THE EXPECTED GREAT COMET.

Of the many grand comets that have been seen, and of which any account has been handed down to us, few or none have surpassed in interest the great comet of 1264, the one which astronomers (and not them only) are now so eagerly expecting. All the writers of the time alluded to it as the most magnificent that had ever been seen by any person then living; and we are informed that on the day on which it was discovered Pope Urban IV. fell sick, and that he died on the night on which it was last seen, October 2, his illness and subsequent death being almost universally ascribed to the comet's pernicious influence. It seems to have been first noticed about the middle of July, although it did not attain its greatest brilliancy until the following month, when it was seen also early in the morning before sunrise. We are told that from the head, which presented a very nebulous appearance, an immense tail issued, which was not less than 100° in length.

Early in March, 1556, a comet became visible, which, although not so large or imposing as the one just mentioned, is still described as "a great and brilliant star." It remained visible for about one month, and then disappeared. The Chinese annals, however, make the duration of its visibility to extend to nearly two months. The comet was carefully observed at Vienna by Paul Fabricius, and a rude map of its apparent course amongst the stars drawn by him has materially assisted in determining its approximate elements. The first set were calculated by Halley. Some fifty years afterwards, Mr. Dunthorne was induced to try and determine, if possible, the elements of the comet of 1264 from two observations said to have been made at Cambridge by Friar Giles, together with such information as was to be found in the writings of old chroniclers. His results proved so similar to those obtained by Halley for the comet of 1556, that he was immediately led to suspect the identity of the two bodies; and as the period seemed to be about 292 years, he concluded that the comet would again return about the year 1848. About twenty years after Dunthorne had published his memoir on the subject, that is to say, about the year 1760, the well-known French cometographer, Pingrè, turned his attention to the question, and after examining a large number of observations and statements not made use of by Dunthorne, he came to the same conclusion, namely, that the comet might be expected again about the year 1848. The subject then remained in *statu quo* until about twelve years ago, when Mr. J. R. Hind investigated again the question of identity, by collecting all the most trustworthy records of the comet of 1556, and deducing an orbit therefrom. The result was, that the orbit obtained by him agreed so nearly with that given by Fabricius in his chart, as to leave no doubt that it was a very close approximation to the truth.

The identity of the two bodies having been satisfactorily proved, M. Bomme, of Middleburg, Holland, at a vast expense of time and labour, calculated the effect that might be produced on the comet's period by the combined attraction of the planets. Taking Hind's elements as his basis, Bomme found that the comet's period in 1264 was 302·922 years, and that planetary attraction would hasten its return by 4077 days. In 1556 the mean period was 308·169 years, and planetary attraction would accelerate its next return by 3828 days; so that the comet might be again in perihelion on August 2, 1858. With Halley's elements Bomme found that the comet's perihelion passage would take place on August 22, 1860. There is there-

fore an uncertainty of about two years in the comet's next appearance, according as to which set of elements is adopted. One and a quarter of two years having passed away without anything having been heard of the comet, we may reasonably expect it in the course of the next few months.

It is worthy of note that brilliant comets appeared in the years 975, 683, and 104, all of which present some indications of identity with the one we have now been considering; "but the accounts we possess are too vague to admit of anything more than conjecture." M. Hock, of Leyden, has made some investigation relative to the first of the above three, but his results throw much doubt on the identity of that with the one of 1556.

GEO. W. F. CHAMBERS.

Eastbourne.

LEAF GEOMETRY.

A HISTORY of discoveries would, at any rate, prove one very remarkable fact, viz., that occurrences the most familiar to us, and things apparently worthless, are pregnant, nevertheless, with truths which acute observers discover as it were by accident, and, thenceforth, the meanest understanding can acquire a knowledge of phenomena which had been for ages staring clever men in the face, and had yet remained undiscovered, though all-important to the general welfare of mankind.

I wish, in this paper, to point out some very simple and interesting, if not useful, phenomena in that very common thing—a leaf. Look at that oak-tree. The branches, as they move gently in the wind, seem to break out from the trunk without any regularity; and the leaves, it would be impossible indeed, at first sight, to see any order or arrangement in their position on the branch. But go up closer, and break off a little sprig, like that in Fig. A. Fix on one leaf, cut half of it off, and then trace up the stem with your finger till you come to the next leaf immediately above it. Now tie a thread to the upper one on the stalk as close as possible to the stem, and draw it down, twisting it round the stalk of each leaf, till you come to the leaf which you had already marked. You will find that you have to pass four leaves before you come to the marked one, and that you have drawn the thread twice round the stem, thus completing the cycle. Now, if you go on downwards on the branch, you will find precisely the same thing; at the fifth leaf below, you will be again exactly under the cut one. So you see that the apparent confusion of the leaves upon yon waving oak is in reality an exact order, which would be at all times perfect, but for the various accidents to which the tree is liable from its exposure to weather and destructive insects.

It has been discovered that the leaves o all plants and trees are arranged in regular order upon their branches, and botanists mark this arrangement, or "phyllotaxis," as they call it, by a fraction, the numerator of which consists of the number of turns round the stem, and the denominator the number of leaves in the cycle. This oak, therefore, is marked by the fraction $\frac{2}{5}$. But there is a great variety of different arrangements of leaves in the common trees and plants which surround us, and it is interesting to find them out. Thus the holly will be found to be $\frac{3}{8}$, the yucca of our gardens $\frac{8}{21}$, and the lime-tree, the yew, and the bean $\frac{1}{2}$. This fraction shows also the distance between the leaves, expressed in parts of the circumference of the circle. This may be seen at once by referring to Figs. B and C, which represent stems with numbers where the leaves are supposed to

grow. In Fig. B, if we begin with No. 1, we have to go three times round the stem before we come to No. 8, which is exactly above it. This arrangement of leaf, therefore, would be marked by the fraction $\frac{3}{8}$; if you look at the circle on the top of the stem, you will see at once that Nos. 1 and 2, which represent the position of the first two leaves, are $\frac{3}{8}$ths of a circle apart. In Fig. C, where we have only to go once round the stem before coming to

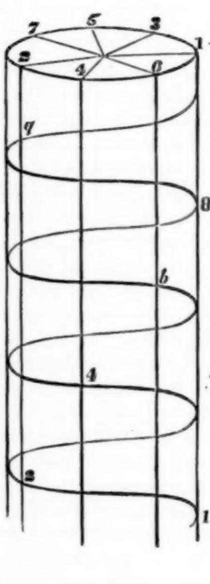


Fig. B.

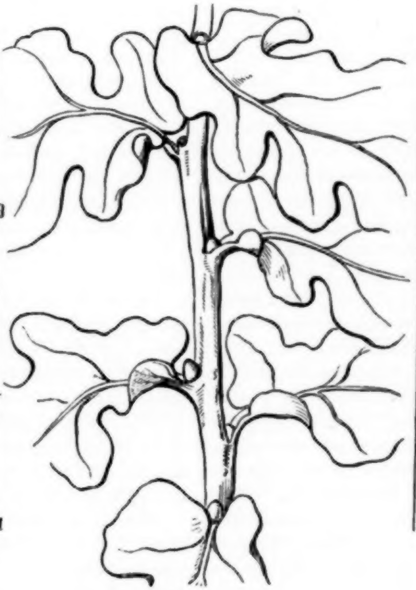


Fig. A.

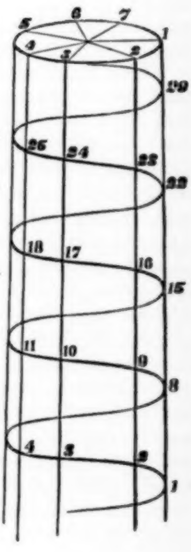


Fig. C.

the leaf exactly above No. 1, the fraction is $\frac{1}{7}$, and at the top it is manifest that Nos. 1 and 2 are $\frac{1}{7}$th of a circle apart. Although the phyllotaxis is invariably the same in the same species, it is sometimes different in different species of the same genus; thus in the European larch it is $\frac{8}{21}$, while in the American larch it is $\frac{2}{5}$. Botanists have discovered, too, that the most common arrangements of leafage are expressed by the following fractions: $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, $\frac{21}{55}$, etc. It will be seen that these numbers bear a singular relation to each other, for the numerator of each fraction is the sum of the two preceding, and the denominator, in the same way, is the sum of the two preceding denominators; besides this, you will find that the denominator of one is the numerator of the next but one after it. This shows a very curious mathematical order, where we should least expect to find it, in the myriads of leaves which are tossed about in wild confusion by the summer breeze.

But a discovery, almost more wonderful than this, has been made by Mr. M'Cosh, for he has found out that "the leaf is a typical plant or branch, and that every tree or branch is a typical leaf." This resemblance,

however, between the leaf and the whole tree can only be traced in leaves whose veins and stem are fully developed. In such, a close analogy has been found between the distribution of the branches on the trunk and the position of the small vein upon the midrib. It will be found in most cases, if not in all, that the angle which the vein makes with the midrib is the same as that between the branch of the tree and the trunk. Mr. M'Cosh has measured the angle of ramification and the angle of venation in an immense number of different trees and plants, and has found the measurement to coincide.

Those trees, which send out branches from the root, or near the root, such as the box, privet, holly, and oak, have leaves in the same way without any, or with a very short, footstalk; whereas the leaves of those trees which have a long unbranched trunk, like the pear, cherry, sycamore, and chestnut, have, generally, also a long footstalk. Hollyhocks, rhubarb, mallow, and other low-branching herbaceous plants, generally send out a group of stems from the root, and, on examination, you will find that several midribs start from the base of the leaf, and cause the leaf to assume a rounded shape. In some trees, like the beech and elm, the branches are almost equally distributed throughout the trunk, and in the same way the small veins are usually distributed on the middle rib. Other trees, like the sycamore and laburnum, send off groups of branches at particular heights, and the venation of the leaves follows the same arrangement. The laburnum has triplet leaves, and a glance will show that the main trunk is divided into three main branches.

Thus an interesting subject of inquiry opens out before any of my readers who live in the country, and to such I hope that leaves, in future, will not be regarded merely as the summer ornaments of our woods and lanes, but that they will find, with Goethe,

"All shapes are similar, yet all unlike,
The chorus thus a hidden law reveals."

GREASE IN THE CABINET.

Grease is a terrible destroyer of specimens in the cabinet of an entomologist. Where does it come from? It is a kind of greasy fluid, which exudes from the bodies of many of our moths, especially of the Bombycidæ, thence spreading over the wings, and eventually spoiling the specimen. Even keeping the drawer continually stocked with camphor will not prevent its appearance; and I do not know what will, but I know how to cure it when it is there.

The plan of operations may be described as follows:—First procure a bottle of *benzole*, which may be got at any chemist's, and which must be kept well stoppered when not used. When about to operate, obtain a deep saucer, or, better, an evaporating dish, in which place your insect, then pour in carefully the benzole till the specimen is entirely immersed; you need not be frightened at wetting it.

It should be left thus for about five minutes, the dish being kept covered up to prevent waste by evaporation. At the end of this time your insect may be taken out and left till all the benzole has evaporated from it, which will not take very long, when it will be found to be in as perfect a condition as when first set out; with one advantage, that of not being likely again to become greasy.

This is not the only means of curing grease, but I find that it far supersedes any other, no especial process being afterwards used to dry the specimen, which is so liable to be detrimental to it; on the contrary, as we have seen, it improves it rather than causing any damage.

The reason of this cure is, that benzole is a solvent of grease; thus, by leaving the insect in it for a few minutes, the grease is entirely dissolved out of it, in this way preventing its future appearance.

L.

METEOROLOGY OF NOVEMBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1842	62·0	27·0	—
1843	58·5	25·5	2·2
1844	56·5	30·1	3·4
1845	60·0	29·0	1·6
1846	58·0	28·0	0·7
1847	61·0	30·0	2·0
1848	54·8	22·7	0·7
1849	58·5	17·5	1·4
1850	61·2	22·0	2·9
1851	52·5	19·2	1·4
1852	60·0	25·0	7·0
1853	57·2	17·5	2·6
1854	57·2	18·7	1·8
1855	54·6	23·1	1·0
1856	55·0	18·2	1·9
1857	60·5	24·5	1·2
1858	57·2	13·2	0·7

The greatest heat in shade reached 62·0° in 1842, and only 52·5° in 1851, giving a range of 9·5° in greatest heat for November during the past seventeen years.

The greatest cold was as low as 13·2° in 1858, and never below 30·1° in 1844, giving a range of 16·9° in greatest cold for November during seventeen years.

Only three-quarters of an inch of rain fell in November, 1846, 1848, and 1858, whilst the very large amount of seven inches fell in November, 1852.

Generally a few very sharp frosts occur. The mean amount of rain for the month, 1·9 inches, as the unusually great amount which fell in November, 1852, has raised the average a quarter of an inch.

E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR NOVEMBER, 1859.

The sun is in the constellation Scorpio till the evening of the 22nd, when he passes into Sagittarius. In London he rises on the 1st at 6h. 55m., on the 15th at 7h. 20m., and on the 30th at 7h. 44m. He sets, at the same place, on the 1st at 4h. 32m., on the 15th at 4h. 9m., and on the 30th at 3h. 53m. On the 4th, at Edinburgh, he rises 17 minutes later than in London, and on the 18th 21 minutes later. On the 14th, he rises at Dublin 9 minutes later than in London, and on the 28th 11 minutes later.

Twilight ends on the 3rd at 6h. 25m.; and day breaks on the 8th, at 5h. 10m., and on the 26th at 5h. 35m. Length of day on the 10th, 9h. 6m.; length of day has decreased on 10th, 7h. 28m., and on 21st, 8h. 2m.

Full moon on the 10th, at 2h. 5m. p.m.

New moon on the 24th, at 1h. 43m. p.m.

The moon is at her greatest distance from the earth on the 3rd, and at her least distance on the 16th. She is near Jupiter on the 15th, Saturn on the 17th, Mars 21st, Venus 25th, and Mercury on the 26th.

Mercury is an evening star, in the constellation Libra, till the middle of the month, and after which in Sagittarius. He is becoming larger and more favourably situated for observation, reaching his greatest easterly elongation on the 26th. On the 27th, he sets at 4h. 56m. p.m. He is seen as a crescent.

Venus is an evening star, but being so far from the earth, and situated so low in the heavens, she will be unfavourable for observation. Venus is now almost circular, and her disc only 10″ in diameter of arc, in the constellation Ophiuchus, except for a few days at commencement of month, when she is in Libra.

Mars is a morning star, and still very unfavourable for observation, his disc being only 4″ in diameter. Every day he will become a better object, although slowly. In the constellation Virgo.

Jupiter is in the constellation Cancer, and very favourably situated for telescopic observation. On the 7th, he rises at 8h. 41m. p.m., and on the 27th, at 7h. 20m. p.m.

Saturn is in Leo for the whole of the month, and a good telescopic object; his rings, however, are not so widely open as they were several years ago. On the 17th he rises 10h. 51m. p.m., on 27th at 10h. 13m. p.m.

Uranus is very favourably situated for observation. He is in Taurus, and *just* visible to the naked eye; he is situated within the triangle formed by the Pleiades, Aldebaran, and τ Tauri, about two-thirds of the distance between Aldebaran and τ, and to the east of the latter star.

Eclipses of Jupiter's Satellites:—The first moon disappears on the 6th, at 9h. 58m. 9s. p.m.; disappears on the 13th, at 11h. 51m. 20s. p.m.; on the 21st, disappears at 1h. 44m. 33s. a.m.; on the 29th, disappears at 10h. 6m. 13s. p.m. The second moon disappears on the 22nd, at 10h. 8m. 37s. p.m., and disappears on the 30th, at 0h. 45m. 5s. a.m. The third moon disappears on the 24th, at 9h. 4m. 1s. p.m., and reappears on the 25th, at 0h. 15m. 7s. a.m.

The sun reaches the meridian on the 2nd, at 11h. 43m. 42s. a.m., and on the 27th, at 11h. 47m. 43s. a.m. Equation of time on the 2nd, 16m. 18s., and on the 27th, 12m. 17s.

Declination, *i. e.*, variation of the compass for London	=21° 30′ W.
Inclination, or dip of the needle	=68° 20′ N.
Total force (in units)	= 10·30.

E. J. Lowe.

Highfield Observatory, Nottingham.

THINGS OF THE SEASON—NOVEMBER.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

Birds Arriving.—Gadwell, Silktail, Widgeon, Golden Plover, Golden-eyed Pocher, Red-headed Pocher, Stock-dove, Hawfinch, Redwing, Fieldfare, flights of Crested Wren occasionally from Norway.

Birds Departing.—Snipe, Water Wagtail occasionally migrates to south of England.

Wild Plants.—Arbutus unedo in flower, Nidularia campanulata, various Agarics, and Lichens.

Mr. Noteworthy's Corner.

New Planet.—We have the pleasure to announce that Dr. R. Luther, of Bilk, discovered another new planet (one of the asteroid group) on the 22nd of September. This is No. 57 of the asteroids, and the 8th which Dr. Luther has had the good fortune to discover. Our solar system now numbers 65. The new planet appears as a star of the tenth magnitude. It is not yet named.

Underground Temperature.—Professor W. Thompson has reduced Professor Forbes's observation of the temperature of thermometers sunk to different depths in the ground, from which we learn that at three feet deep the greatest cold of winter does not occur till February, at six feet not till March, at twelve feet in April, and at twenty-four feet in July. So that at the latter depth *summer* becomes *winter*. Let us take a practical hint from this, and make ourselves some *cool* places, into which we may retire in hot weather.

Flint Implements in the Drift.—Sir Charles Lyell's version of this subject, before the British Association, points to the conclusion that there is no necessary chronological connection between the works of man, and even the remains of man, and the strata in which both may be found. Dr. Anderson, in his paper, more decisively stated that flint weapons, skulls, and elephant remains were sometimes quickly petrified, buried in ancient strata by subsidence, or by the falling in of the roofs of caverns, in which men had taken up their abode. "He saw no evidence, deducible from the superficial drifts, to warrant a departure from the usually accepted data of man's very recent introduction upon the earth."

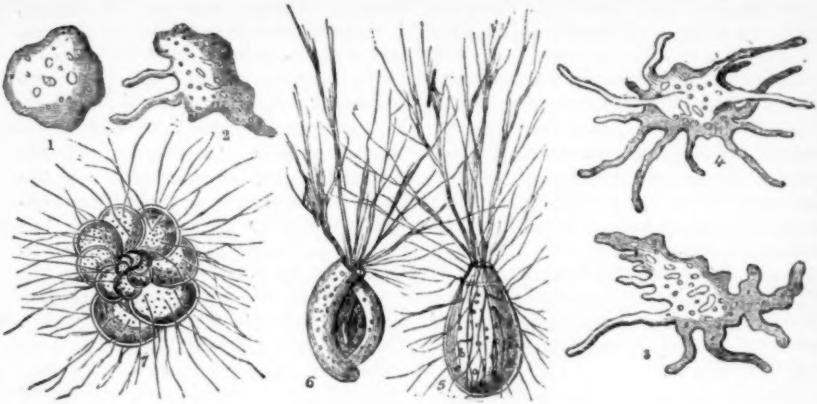
Purification of Water.—Professor Faraday has been making inquiries, at the instance of the Trinity House, into the character of the water obtained for domestic purposes by the residents in lighthouses. It is, he says, invariably impregnated with lead, and hence injurious to health. But the purification of such poisonous water is most easily accomplished. "I ascertained that if a little whiting or pulverized chalk were added to such water, and the whole stirred together, the lead immediately assumed the insoluble form, so that when the water was either filtered, or left to settle, the clear fluid was obtained in a perfectly pure and salubrious condition." Mr. D. J. Heath, in a letter to the *Times*, advises the use of Perkins's small condenser, applied to the waste-pipe of an ordinary kitchen boiler, as an inexpensive mode of obtaining distilled water where it is impregnated with lead or chalk. The return is from six to eight gallons per day.

Big Ships.—A very instructive diagram of the relative dimensions of big ships may be drawn with the help of a scale rule, and would be of value in schools, and a subject of interesting reference to all who give attention to such matters. The following figures furnish the details for a diagram of fifteen of the largest vessels ever built, and it will be seen that their united lengths amount to a mile:—Great Eastern, 580 feet, 19,000 tons; Adriatic, 390 feet, about 3500 tons; Niagara, 375 feet, 4580 tons; Himalaya, 360 feet, 5000 tons; Duke of Wellington, 240 feet, 2400 tons; General Admiral, 325 feet, 6000 tons; Orlando (recently launched for the British Navy), 337 feet, 3727 tons; Atrato, 336 feet, 3476 tons; Royal Charter (running "inside 60 days" from Liverpool to Melbourne), 306 feet, 2720 tons; Great Republic, 302 feet, 3356 tons; Pennsylvania, 300 feet, 3211 tons; Arabia, 300 feet, 2402 tons; Great Britain, 274 feet, 3500 tons; Asia, 280 feet, 2226 tons; total, 5181 feet, 68,428 tons.

Toads in the Heart of Trees, etc.—The wonderful stories about toads being discovered in the hearts of trees, in the centre of large massive stones, and in solid rocks, wherein it is said they have been embedded for many years, are now nearly silenced. The late Dr. Buckland considered, from observation, that toads *cannot live a year*, if totally excluded from atmospheric air; and even if an occasional supply of air were given them, he regarded it as impossible that they could exist two years if kept entirely without food. A supply of oxygen is necessary for the performance of the functions of cold-blooded animals, although the demand for it is much less than in warm-blooded ones. The quantity necessary for the purpose increases with an increase of muscular exertion, and the oxygen which is consumed is replaced by carbonic acid gas which must be removed. It causes the death of animals which inhale it even in small quantities. Reptiles, and most invertebrata that inhabit the land, became apparently inanimate when the temperature is lowered beyond a certain point. In this state their circulation and respiration appear to cease entirely, and the animals may be prevented from reviving for a while, without their vitality being permanently destroyed, if they be surrounded by an atmosphere sufficiently cold. Frogs and serpents have been kept in an ice-house for three years, and at the end of that period have been completely revived.

The Moon's Motion.—It is shown that Mr. Adams and M. Delaunay have arrived at the same result by two different methods of reasoning, and they prove that the acceleration is not nearly as much as before anticipated, and this value is far too small to satisfy the ancient eclipses; and, therefore, some other causes (such as a resisting medium), totally different from the disturbing influences of the sun and planets, must be resorted to, or, as Mr. Main remarks, "we must hope, from a hint dropped by M. Delaunay, that he has some means, at present kept out of sight, for laying the ghost which he has helped to raise."

The Banana at Kew is the most extraordinary plant in the whole of that extensive collection. It was introduced to Europe by Mr. Plowden, and has attained, during five years' occupancy of the palm-stove, a height of more than 30 feet, and the stem is 7½ feet in circumference.



TYPICAL FORMS OF RHIZOPODA.

Amœbida.—Fig. 1, Amœba diffluens, contracted. Figs. 2, 3, 4, the same, with the pseudopodia, more or less extended.
Gromiada.—Fig. 5, Gromia oviformis, with the pseudopodia protruded.
Foraminifera.—Fig. 6, Miliola, and Fig. 7, Rotalia Beccarii, with pseudopodia protruded.

MICROSCOPIC GEOLOGY.

I.—ROCK-FORMING MICROZOA—THE FORAMINFERA.

All around us is an invisible world, unseen by our natural senses. Microscopic living creatures and vegetable organisms swarm in earth, water, and sky; but the eyes of the many never behold them. Nothing is free from them. We find them in the clearest water, and in the strongest acids; in the internal moisture of living plants, and in the fluids of animal bodies. They are carried about by the storms and winds; they fall like powder on the decks of ships thousands of miles away from land, and Ehrenberg has found them even in meteoric dust. By their immense numbers they colour large tracts of water with remarkable hues. That beautiful phenomenon, phosphoresence of the sea, is due to the accumulation of myriads of minute jelly-globes; while a cubic inch of mouldering earth may contain upwards of forty thousand tiny scavengers.

No one can think of them without raising his eyes in adoration to their Maker; and no one can see them and study them without feeling how exquisite is the handiwork of the Infinite Designer in these his minutest creations, even as it is grand and overwhelming in the vastness of the systems of worlds rolling on in the boundless realms of star-lit space.

As it is now, so it has been, one might almost say, from the beginning. At any rate, some of the oldest strata of the palæozoic age—the silurian—present us with marine species closely like the living forms of the same class still swarming on our shores and in our seas. The waters of the Niagara, for ten thousand years, have plunged over a ledge of steep cliff, even as they do now. In the superficial alluvial soil they have left the marks of their headlong rushing as plainly as they

have inscribed their records on the stony cliff-walls of the gorge through which their eddying waters foam onwards to the sea. How many ages older than that wonderful cataract those alluvial gravels are no man can tell; but older, indeed, they must be, referring as they do to former geological and physical changes and conditions of the land. And yet, while on a vertical scale of the rock-strata, where an inch would represent a thousand feet, the whole era of the full deposit of those alluvial beds, in all their thickness, would not be equal to a pen-line, the level of these first-known traces of marine Foraminifers would be some six or seven feet down.

During all those vast intermediate ages, such tiny living things have swarmed in ocean, lake, and river, in earth and air. We cannot break down any friable freestone, such as oolite or Bathstone, any sandstone, limestone, or clay, without finding abundant specimens of ancient Microzoa in the dried and sifted dust. In those rocks, too compact to be reduced mechanically to powder without crushing, such as the limestone from Dudley, the marble from Matlock or Westmoreland, very thin polished sections will reveal, under the magnifying power of the microscope, some of their beautiful and peculiar forms. Some rock-masses, indeed, such as chalk and various tertiary marls, are wholly composed of the perfect and well-preserved shells and cases of ancient minute organisms.

Amongst these microscopic fossils, however, are two classes, which beyond all others have played, as they still continue to do, a most important part in the accumulation of massive sedimentary strata. Over how many thousands of square miles in Europe alone does the chalk, that in the lofty cliffs of Dover and of France presents us with a thickness of a thousand feet, extend? And yet, in every cubic inch, a million perfect individuals may be counted, besides the broken shells and fragment-dust with which they are cemented together. So minute, sometimes, are these rock-forming Microzoa, that in the polishing slate of Bilin, for example, forty-one thousand billions are estimated within the same limit of a cubic inch, In the former, the chalk, the organisms are, however, much larger and marine; still they require a magnifying power of at least 250 linear, or 62,500 times, to render them intelligibly, and a far higher power than this for the examination of their intimate structure. In the latter, the Bilin slate, the organisms are, for the most part, the silicious lorica of vegetable diatoms, such as Mr. Tuffen West has already described in a recent state in his papers in this work.

For the past seventy years, microscopic objects, whether vegetable or animal, have, for the most part, been commonly described and spoken of as Infusoria, a name they first derived from the almost universal presence of animated atoms in water in which flower-stalks had been steeped, and in other vegetable *infusions*. The severer scientific scrutiny to which this, like every other department of natural history has of late years been subject, has shown that many very different classes, both of animals and vegetables, have been improperly included and grouped under this now restricted title.

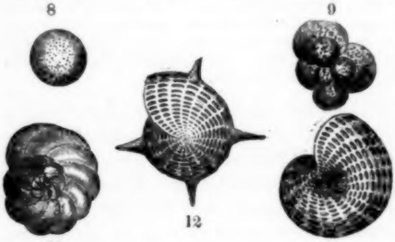
Of the two classes of minute animals which we have alluded to as principal constituents of some rock-masses, neither is infusorial. One of these, the Foraminifera, belongs to the lowest grade of animal life—the Protozoa, or *globular* animals; the other, the Entomostraca—however at first sight it may seem to diverge from the familiar crab or lobster type—belongs to the Crustacea, or *crust-shelled* animals, one of the principal sub-divisions of the Articulate or *ring-formed* group. Of each of these kinds innumerable hosts are living at the present hour, and they are as easily obtained in their living as in their fossil state.

It will be well, however, in this paper,

lest we should become too discursive, to confine ourselves to one class, and, from their great antiquity, the Foraminifera hold the first claim to our attention.

All are familiar with the household sponge, and it is now very generally known that sponge, with its curious tissue of interlacing fibre, is but the horny skeleton of a marine animal of the lowest condition of life; the like horny skeletons of small British

8 9



12

10 11

Hyaline-shelled Foraminifera (Globular arrangement, running into Nautiloid).

Fig. 8, Orbulina universa, D'Orbigny. 9, Globigerina bulloïdes, D'Orb. 10, Rotalina Partschiana, D'Orb. 11, Polystomella Fichtelliana, D'Orb. 12, P. Regina, D'Orb.

sponges are commonly cast by the waves on our beaches. But still few know the animal itself of the sponge, or would recognize what it was if they saw it. The investing animal substance of these horny skeletons was a soft thin jelly, called by naturalists "sarcode." It possessed no visible muscular structure, and yet it had some slight power of contraction and expansion, some slight capacity of voluntary movements. Through the smaller pore-like cavities with which the skeleton of the sponge is seen to be perforated, the ocean-water was inhaled in a current produced by the paddle-action of the numerous minute cilia (or thread-like distensions of sarcode) with which the internal surfaces of those channels were lined, while the water thus inhaled was expelled by the fewer and larger tubular orifices denominated oscula. The sponge itself was rooted to one spot from the period of its first settlement—for while young as a gemmule it swam freely about—to the end of its life, and the sponge of commerce is no more, as we have said, than the mere framework of the creature, which, dredged from its native depths, has been kicked and trodden and blown about, on the sands of the Mediterranean, until every particle of its animal substance has been wasted and destroyed; and the dust, so full of exquisite microscopic objects, which we shake out from the fibrous network, is nothing more than the sand of those sea-shores, and not particles of food, as has been sometimes ignorantly supposed. Dr. Bowerbank has observed that the jelly-like sarcode of the sponge can form itself into temporary stomachs, into which the food brought in by the inhalent currents of water is received, digested, and assimilated, after which the sarcode resumes its smooth, jelly-like appearance,—so simple is the organization of the sponge-animal!

The fibrous structure of fossil sponges of a high class, the ventricalities, is beautifully preserved in the flint nodules of the chalk, and exhibits under the microscope wonderful and remarkable designs, as has been admirably elucidated by Mr. Toulmin Smith.

The jelly-flesh condition is not confined to the sponge; other animals having free locomotion are formed of it. That microscopic "proteus" the Amœba is nothing more than an atom of such sarcode. It has no cilia, no power of swimming; but if we watch it, bud-like knobs are seen to be slowly protruded from its body and gradually extended into pseudopodia, or false feet, more than equal to the diameter of the body (see woodcut, p. 145, Fig. 1). The ends of these artificial limbs attach themselves sucker-like to the surface over which the creature is travelling, contract, and thus gradually drag up the body (see woodcut, p. 145, Fig. 2). Again, elongating knobs are protruded into feeler-like limbs, which again, contracting like

elastic ropes, haul the body along. Thus the Amœba, ever changeful in its form (as its name implies), travels along, investing in its jelly-flesh as it progresses atoms of food, which thus entangled and enveloped by its pulpy flesh are so digested.

Besides the naked Amœbas there is the similar group of Gromias, in which the sarcode is inclosed and protected by a bag-like cuticle, from the aperture of which alone are the pseudopodia extruded (see woodcut, p. 145, fig. 3.)

Another class of jelly-flesh animals is possessed of shelly coverings—these are the Foraminifera, to which we have already alluded. These sometimes consist of a single globule of sarcode coated with a calcareous skin

13 14 15 16 17 18

19 20 21 22

Hyaline-shelled Foraminifera (Bead-like arrangement, running into Nautiloid).

Fig. 13, Lagena (Oolina, D'Orbigny) clavata. *Genus*, NODOSARINA. 14, Dentalina elegans, D'Orb. 15, Nodosaria rugosa, D'Orb. 16, N. hispida, D'Orb. 17, N. spinicosta, D'Orb. 18, N. bacillum, D'Orb. 19, Frondicularia annularis, D'Orb. (*Chevron-style*). 20, Flabellina rugosa, D'Orb. (*Spiral and chevron*). 21, Cristellaria lanceolata, D'Orb. 22, Cristellaria Josephina (*Nautiloid*).

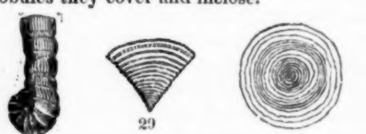
or shell; sometimes a second globule—for the Foraminifera grow by gemmation, a common method of increase amongst the lower grades and microscopic forms both of animal and vegetable life—is formed upon and overlaps the first. Often the adult Foraminifer is constituted of a succession of such unseparated globules of lime-coated sarcode, developed in linear order on a straight or on a curved line, or in a spiral arrangement, or alternated in twists and braids, or in disc-like

23 24 25 26 27

Hyaline-shelled Foraminifera (Braid-like arrangement).

Genus, POLYMORPHINA. Fig. 23, Polymorphina lactea, *var.* horrida (Globigerina tubulosa, D'Orb.) 24, Polymorphina complanata, D'Orb. 25, Uvigerina pygmea, D'Orb. 26, Textularia Mariæ, D'Orb. 27, Textularia deperdita, D'Orb.

or shell-like types, the latter often putting on a nautiloid appearance. In the early days of Natural History science this has caused such Nautilus-resembling Foraminifera to have been figured and described, by even some eminent naturalists of the old school, amongst them by Linnæus himself, as the minute young, or as particular species of that genus of cephalopods; they overlooking in those statements the fact that the walls of the chambers of the Nautilus are incurved to admit the inhabitation of the outermost cell by the animal, while the separating perforated walls of the Foraminifera—for the shelly coverings of most of these little living jelly-lumps are perforated like sieves, with orifices for the protrusion of their pseudopodia—always retain the globular shape of the jelly-globules they cover and inclose.



28 29 30

Opaque-shelled Foraminifera (Circular and other arrangements).

Fig. 28, Peneroplis (Spirolina, D'Orb.) Austriaca. 29, Pavonina (Cuneolina, D'Orb.) triangularis. 30, Cyclolina cretacea, D'Orb.

Wonderful indeed in these Foraminifera are the beautiful, elegant, and varied forms produced by the different arrangements of

the divided, but unseparated, incrusted sarcode-globules. One of the most common Foraminifera is the Miliola—so called from

31 32 33

Opaque-shelled Foraminifera (Arrangement alternately lateral).

Fig. 31, Spiroloculina canaliculata, D'Orbigny. 32, Triloculina pulchella, D'Orb. 33, Hauerina compressa, D'Orb. (putting on spiral).

its resemblance to a millet-seed—found abundantly in the heaps and ridges of sea-weed left by the receding tides upon the sands. Like the Gromia these have only a single aperture for the extension of the pseudopodia formed by their extensile flesh, and it is a curious and interesting sight to watch them slowly hauling themselves up and along the transparent sides of a glass tumbler or the walls of an aquarium.

The Miliola were noticed long ago by naturalists, who put them amongst the Serpula, or encased sea-worms, on account of their appearing to be folded tubes, in like manner as the Rotalia and other similar forms were described in books as minute Nautili; and it was not until 1835 that Dujardin showed their true position in the animal scale as Rhizopods, or *root-foot* animals.

The Foraminifera are all marine, and every zone of sea-depth has its peculiar species or varieties—the deepness or shallowness of the region in which they exist often causing very considerable differences in the appearance of the individuals: thus the *Rotalia repanda* grows large and thick—so to speak of a microscopic shell—in shallow seas, and becomes flattened when obtained from deeper water. Another kind, the *Globigerina bulloïdes*, on the contrary, becomes dwarfed and small in shallow water, but grows large and abounds in deep-sea regions.

In the abysses of the ocean these microscopic shells constitute almost the only material of its oosy bed. In the soundings made for the Atlantic Telegraph, the lead brought up, in regions beyond the range of earthy sediments brought by currents, from depths of three miles, whitish clayey mud all but wholly composed of Globigerinæ.

In the blackness and stillness of those enormous depths, extracting the minutest particles of lime from the dense waters, these little beings live in myriad hosts, and, tiny as they are, accumulate in slowly passing ages into enormous masses of calcareous strata, convertible, ultimately, into limestone, as Time, in his endless circles, shall bring round another change of land and sea, and the bottom of the deep shall be converted into the mountain range.

Thus, too, the Foraminifera have played, in geologic ages, a like important part in the formation of the rock-beds of the earth's stony crust. No organic creature, large or small, has contributed so much material: every limestone, every sandstone, every clay, from the silurian epoch to the present hour, offer the evidences in their remains. A certain green sandy clay, of silurian age, in Russia, is constituted, in great part, of sand, the particles of which are stony casts or moulds of the chambers of Foraminifers, like as the sand dredged to-day in the Gulf of Mexico consists of silicate of iron modelled in the cavities of such microscopic shells. The mountain-limestone—so beautifully studded with coral-branches, and encrinital stems—abounds with their tiny carcases. A Russian limestone of the same age is wholly composed of Fusilina, and other small forms; while similarly constituted rocks occur in America, and in the Arctic regions.

The oolitic freestones have generally a Foraminifer in nearly every one of those spherical egg-like grains (from which they derive their geological name), like as is found in the sand-grains on the shores of modern coral-reefs. The white chalk is, as we have already

said, almost wholly composed of their tender shells.

The "nummulite-limestones" of the Alps, the Apennines, and the Himalayas are other instances of rock-formed mausoleums of these tiny fossils.

Alveolites abound in the "rice-stone" of Persia, and numerous other instances of every period could readily be cited, were they wanted, to show how, throughout all time since the creation of life on our globe, the perished armies of these microscopic labourers have built up, flake by flake, and film by film, the solid rock-masses of steep wave-beaten cliffs, of grassy plains, and mist-clad hills. Small and feeble, and exquisitely minute, with but few of the gifted powers of life, how much they have done shows how truly God's "thoughts are not as our thoughts," but immeasurably above them, how the simplest means at his command produce stupendous results, how everything, even the meanest, is worthy of man's study and thought. "God," says old Ray, in his lovable philosophic spirit, "God is said to be *maximus in minimis*. We men esteem it a more difficult matter, and of greater art and curiosity, to frame a small watch than a large clock; and no man blames him who spent his whole time in the consideration of the nature and works of a bee, or thinks his subject was too narrow. Let us not then esteem anything contemptible, or inconsiderable, or below our notice-taking, for this is to derogate from the wisdom and art of the Creator, and to confess ourselves unworthy of those endowments of knowledge and understanding which He hath bestowed upon us. Do we praise Dædalus, and Archytas, and Hero, and Callicrates, and Albertus Magnus, and many others which I might mention, for their cunning in inventing, and dexterity in framing and composing a few dead engines or movements, and shall we not admire and magnify the Great Δημιουργος Κοσμου, *Former of the World*, who hath made so many, yea, I say innumerable, rare pieces, and those, too, not dead ones, such as cease presently to move so soon as the spring is down; but all living, and themselves performing their own motions, and those so intricate and various, and requiring such multitude of parts and subordinate machines, that it is incomprehensible what art, and skill, and industry, must be employed in framing one of them."

S. J. Mackie.

A CALENDAR OF NATURE.

One branch of scientific inquiry, which the amateur observer is likely to take an interest in, is that of recording a Calendar of Nature. We mean, keeping a record of the arrival and departure of migratory birds, the dates of trees coming into and losing their leaves, the blooming of plants, the ripening of fruit and seeds, the building of birds' nests, the first appearance of different insects, diseases amongst animals and plants, the failure or prolific harvest of corn, fruit, etc.; in short, a correct statement of the appearance of everything in Nature which is seen around us.

There are many of these calendars kept, yet scarcely one can be made available to science, and this owing to the want of proper precautions. It is evident that if it were known what kind of observations would be really useful, that many would lend a helping hand, who now stand aloof simply because it is not seen how such labour can benefit science.

The effects of the weather on the vegetable kingdom is strikingly shown, when a careful series of observations has been made year after year. In illustration, we need only refer

to the spring of 1859. For many weeks vegetation was a month in advance of ordinary seasons, yet one week's cold, at the commencement of May, was sufficient to cause the growth of plants to be checked to an extent so great, that the month previously gained was lost in a few days.

Observations, to be comparable with each other, require recording year after year, in the same place, and on the same individual plants. It is by no means an uncommon occurrence to find two trees of the same species (whose boughs actually cross each other) vary as much as a fortnight in their time of leafing or flowering. It would be useless to say, the elm lost its leaves on a certain day, without particularizing the particular kind of elm meant; thus, the broad-leaf elm is the first tree to become leafless, which it frequently does in September, whilst the Siberian elm, on the contrary, will retain its leaves after all others have been denuded of them; sometimes this plant is in leaf as late as December. The age of a tree or plant will cause some difference.

Migratory birds will arrive at one spot much earlier than they will at another, even when so contiguous that a single minute on the wing would enable a bird to reach the other spot; however, this they never attempt until the proper time has arrived. Swallows and martins are seen near the Trent for days before they are found on the hills only a mile from this river.

Different kinds of lilacs and laburnums will have a range of some days in their period of coming into bloom.

Amongst herbaceous plants, those which have been transplanted during the year should either be avoided, or a special record made regarding them. Annuals are only worthy of secondary note, as the time of sowing must be taken into account, unless the seed is *self-sown*. Again, amongst such observations as the ripening of fruit, the different kinds require specification. As an instance, the strawberry known as Black Prince will ripen before Kean's Seedling, Kean's Seedling before British Queen, and British Queen before the Elton Pine; and again, one-year-old plants of Black Prince will ripen sooner than those on two or three-year-old plants.

In recording the flowering of plants, it is advisable to give the dates when the first blooms are expanded, as well as those when in full glory of bloom, and when the blooming is over. Wheat and other grasses should have the dates when the ears are first visible, when the flower-spikes are above the leaves (in full ear), and when in flower.

As the objects are so multifarious, it is requisite to pay especial attention to a certain list (which has been compiled with much care), in order to insure a comparison between two or more observers. The nature of the soil, the geological formation, and the geographical position of the place of observation are also essential in these investigations.

Such a series of observations as the above, carried on for a course of years, and more especially by meteorologists (who have the additional opportunity of comparing them with the weather records), cannot fail to be productive of much good to science, as, when brought together, they would form a valuable collection of facts for the naturalist and meteorologist to generalize upon.

OBJECTS WORTHY OF ESPECIAL NOTICE.

1.—Leafing of Trees.

Narrow-leaved elm (Ulmus campestris).	Birch (Betula alba).
Elder (Sambucus nigra).	Elm (Ulmus glabra).
Sycamore (Acer pseudo-platanus).	Elm (Ulmus montana).
Crab (Pyrus malus).	Pear (Pyrus communis).
Mountain ash (Pyrus aucuparia).	Plane (Platanus occidentalis).
Hawthorn (Cratægus oxycantha).	Plane (Platanus orientalis).
Aspen (Populus tremula).	Tulip-tree (Liriodendron tulipifera).
White poplar (Populus alba).	Lime (Tilia Europæa).
Hazel-nut (Corylus avellana).	Apricot (Armeniaca vulgaris).
	Ash (Fraxinus excelsior).
	Oak (Quercus robur.

Spanish chestnut (Castanea vesca).
Beech (Fagus sylvatica).
Willow (Salix helix).
Mulberry (Morus alba).
Mulberry (Morus nigra).
Larch (Pinus larix).
Currant (Ribes nigrum).
Walnut (Juglans regia).
Maiden-hair tree (Salisburia adiantifolia).

2.—Ripening of Fruit.

Gooseberry.—Ribes grossularia; varieties, Rumbullion, Champagne, Rough Red, Wonderful.

Cherry Laurel (Common Laurel).—Cerasus laurocerasus.

Filbert.—Corylus avellana.

Hazel-nut.—Corylus colurna.

Currant.—Ribes nigrum; varieties, Black Naples, Red Dutch, White Dutch, Goliath, and Salmon.

Pear.—Pyrus communis; variety, Jargonelle.

Apricot.—Armeniaca vulgaris; variety, Moorpark.

Peach.—Persica vulgaris; varieties, Royal George and Noblesse.

Nectarine.—Persica lævis; varieties, Elruge and Violet Hative.

Plum.—Prunus domestica; varieties, Greengage, Magnum-bonum, Damson, Golden Drop, and Wine Sour.

Cherry.—Cerasus duracina; varieties, Early Duke and Morello.

Strawberry.—Fragaria vesca; varieties, Black Prince, Kean's Seedling, British Queen, and Elton.

Raspberry.—Rubus Idæus; variety, Antwerp.

Apple.—Pyrus malus; varieties, Juneaton, Keswick codling, Eve Apple, Normanton Wonder, and Besspool.

3.—Flowering of Plants.

Primula auricula (Auricula).
Avena sativa (Oat).
Aster bellidiflorus.
„ ericoides.
Azalea calendulacea.
„ nudiflora.
„ pontica.
„ speciosa.
„ viscosa.
Hordeum vulgare (Barley).
Faba vulgaris (Bean).
Ligustrum vulgare (Privet).
Veronica chamædrys (Wild Germander).
Crocus vernus (Purple Crocus).
„ aureus (Golden Crocus).
Iris pseudacorus (Yellow Water Iris).
Eriophorum angustifolium (common Cotton Grass).
Galium verum (Yellow Bed Straw).
Myosotis palustris (Great Water Forget-me-not).
Myosotis intermedia.
„ azorica.
Primula vulgaris (Primrose).
Primula veris (Cowslip).
„ farinosa (Mountain Auricula).
Lysimachia nemorum (Yellow Pimpernel).
Lonicera Periclymenum (Woodbine).
Viola odorata (Violet).
Gentiana acaulis (Gentian)
„ verna.
Ribes atrosanguineum.
„ rubrum.
„ nigrum (Currant).
Saponaria ocymoides.
Cytisus alpinus (Scotch Laburnum).
Cytisus laburnum.
Pyrus aucuparia (Mountain Ash).
Pyrus communis (Pear).
Narcissus Jonquilla (Jonquil).
Narcissus pœticus.
„ minor.
Nepeta teucriifolia.
„ glechoma (Ground Ivy).
Spiræa ariæfolia.
Helianthus annuus.
" multiflorus plenus.
Syringa Persica (Persian Lilac).
Syringa vulgaris.
„ „ alba.
Tritoma uvaria.
Ulex Europæa flore-pleno (Gorse).
Valeriana officinalis (Valerian).
Ribes grossularia (Gooseberry).
Gordonia lasianthus.
Campanula rotundifolia (Harebell).
Hepatica Americana (Hepatica).
„ „ alba.
„ „ rubra.
Hyacinthus orientalis (Hyacinth).
„ „ albus.
Iberis sempervirens (Candytuft).
Iris graminea.
„ pumila.
Hippeastrum formosissimum.
Liriodendron tulipifera (Tulip-tree).
Lonicera pubescens.
Lupinus polyphyllus.
Plum (prunus domestica).
Damson Plum.
Plumbago Larpentæ.
Polygonatum vulgare (Solomon's Seal).
Polygonum Sieboldtii.
Rhododendron caucasicum.
„ ferrugineum.
„ ponticum.
Veronica alpina.
Saxifraga oppositifolia.
Scilla amœna.
„ bifolia.
„ Sibirica.
Medicago arborea.
Œnothera fruticosa.
„ macrocarpa.
Pæonia moutan (Tree Pæony).
„ albiflora Pottsii.
„ officinalis rubra.
Papaver alpinum.
„ orientale.
Veratrum nigrum.
Vinca major.
Weigela rosea.
Yucca gloriosa.
„ filamentosa.
Zauschneria Californica.
Geum coccineum.
Gladiolus communis.
Wistaria sinensis.
„ alba.
Jasminum officinale (Jasmine).
„ nudiflorum.
Kalmia latifolia.
Phaseolus vulgaris (Kidney Bean).
Viburnum tinus (Laurestine).
Cerasus lusitanica (Portugal Laurel).
Lavandula spica.
Ledum latifolium.
Leucojum æstivum (Summer Snowflake).
Lilium lancifolium.
„ aurantium.
„ candidum.
„ Martagon.
„ tigrinum.
Magnolia grandiflora.
Viburnum opulus (Guelder Rose).
Sambucus nigra (Elder).
Berberis vulgaris (Barberry).
Galanthus nivalis (Snowdrop).
Narcissus pseudo-narcissus (Daffodil).
Hyacinthus non-scriptus (Wild Hyacinth).
Convallaria majalis (Lily of the Valley).
Saxifraga granulata (Saxifrage).
Dianthus caryophyllus (Clove Pink).
Dianthus deltoides (Maiden Pink).
Silene inflata (Bladder Campion).
Oxalis acetosella (Wood Sorrel).
Sedum telephium (Orpine).
Sedum acre (Wall Pepper).

Spiræa ulmaria (Meadow Sweet).
Rosa spinosissima (Rose).
„ tomentosa.
„ canina.
„ arvensis.
Rose Brennus.
„ Géant des Battailes.
„ Mrs. Bosanquet
„ William Jesse.
„ Coupe d'Hébe.
„ Cramoise supérieure.
Trollius Europæus (Globe Flower).
Caltha palustris (Marsh Marygold).
Anemone nemorosa (Wood Anemone).
Ranunculus acris (Crowfoot).
„ ficaria (Lesser Celandine).
Lamium vulgatum (Dead Nettle).
Humulus lupulus (Hop).
Taxus baccata (Yew).
Linaria vulgaris.
Digitalis purpurea (Foxglove).
Cheiranthus cheiri (Wallflower).
Geranium pratense (Blue Crane's-bill).
Polygala vulgaris (Milkwort).
Ulex Europæus (Gorse).
Cytisus scoparius (Broom).
Ononis arvensis (Rest Harrow).
Corylus avellana (Hazelnut).
Carduus alpestris.
Ceanothus dentatus.
Cerasus lauro-cerasus (Laurel).
Helleborus niger.
Chrysanthemum Achilleæ.
„ sinense.
Clematis cœrulea.
Daphne Mezereum.
„ cneorum.
„ pontica.
Ornithogalum umbellatum (Star of Bethlehem).
Fritillaria Meleagris (Fritillary).
Erica tetralix (Heath),
„ Mediterranea.
Calluna vulgaris (Ling).
Butomus umbellatus (Flowering Rush).
Arbutus unedo (Arbutus).
Agrostemma Githago (Corn Cockle).
Lychnis flos-cuculi (Ragged Robin).
„ vespertina (White Campion.
Prunus spinosa (Sloe).
„ avium (Wild Cherry).
„ padus (Bird Cherry).
Cratægus oxyacantha (Hawthorn).
Pyrus malus (Crab).
Rubus fruticosus (Blackberry).
Papaver rhœas (Corn Poppy).
Meconopsis Cambrica (Welsh Poppy).
Glaucium luteum (Horned Poppy).
Chelidonium majus (Celandine).
Helianthemum vulgare (Rock Rose).
Tilia Europæa (Lime).
Nymphæa alba (Water Lily).
Nuphar lutea (Water Lily).
Allium pulchrum (Yellow Onionwort).
Alyssum saxatile.
„ tortuosum.
Andromeda floribunda.
Anemone japonica.
Antirrhinum majus.
Lotus corniculatus (Bird's-foot Trefoil).
Vicia cracca (Tufted Vetch).
Hypochæris radicata (Long Rooted Cat's-ear).
Leontodon taraxacum (Dandelion).
Tanacetum vulgare (Tansy).
Tussilago farfara (Colt's-foot).
Bellis perennis (Daisy).
Achillea millefolium (Yarrow).
Orchis maculata.
Carex præcox.
Delphinium Chinense.
„ grandiflorum.
„ formosum.
Dianthus barbatus (Sweet William).
Dielytra spectabilis.
Draba aizoides.
Eranthis hyemalis (Winter Aconite).
Faba vulgaris equina.
Matricaria parthenium flore-pleno (Feverfew).
Ornus Europæa (Flowering Ash).
Forsythia viridissima.
Dictamnus fraxinella.
Fuchsia virgata.
Funkia ovata.

4.—Arrival of Migrating Birds.

Spotted Flycatcher (Muscicapa grisola).
Cuckoo (Cuculus canorus).
Nightjar (Caprimulgus Europæus).
Swift (Hirundo apus).
Swallow (Hirundo rustica).
Martin (Hirundo urbica).
Sand Martin (Hirundo riparia).
Fieldfare (Turdus pilaris).
Redwing (Turdus iliacus).
Reed Warbler (Sylvia arundinacea).
Nightingale (Sylvia luscinia).
Blackcap (Sylvia atricapilla).
Whitethroat (Sylvia cinerea).
Chiff-chaff (Sylvia rufa).
Woodcock (Scolopax rusticola).
Landrail (Crex pratensis).

5.—Building of Nests.

Spotted Flycatcher.
Rook.
Swallow.
Starling.
Landrail.
Hedge-accentor.
Redbreast.
Thrush.
Blackbird.
Blackcap.
Partridge.
Wild Duck.
Titmouse.
Lark.

6.—Arrival of Insects.

Magpie Moth (Abraxas grossulariata).
American blight (Aphis lanigera).
Rose Fly (Aphis rosæ).
Apple Fly (Aphis pyrimali).
Peach Fly (Aphis persicæ).
Plum Fly (Aphis pruni).
Bean Fly (Aphis fabæ).
Currant Louse (Aphis ribis).
Codlin Moth (Carpocapsa pomonella).
Earwig (Forficula auricularis).
Lackey Moth (Phalæna neustria).
Goat Moth (Phalæna Cossus).
Julus terrestris (Millipede).
„ pulchellus (do.)
„ complanatus (do.)
Figure of Eight Moth (Phalæna cæruleocephala).
Onion Fly (Anthomyia).
Apple Weevil (Anthonymus pomorum).
Red Spider (Acarus tellarius).
Peacock Butterfly (Papilio Io).
Father Long-legs (Tipula oleracea).
Lady-bird (Coccinella septem-punctata).
Turnip-flea Beetle (Haltica nemorum).
Apple-bark Beetle (Bostrichus dispar).
Typographer Beetle (Bostrichus typographus).
Gamma Moth (Noctua gamma).
Garden Beetle (Melolontha horticola).
Celery Fly (Tephritis onopordinis.
Cockchafer (Melolontha vulgaris).
Buff Tip Moth (Hammatophora bucephala).
Cabbage Moth (Noctua brassicæ).
Hawk Fly (Scæva ribesii).
„ („ pyrastri).
Red Admiral Butterfly (Papilio Atalanta).

Garden White Butterfly (Papilio Brassicæ).
Orange Tip Butterfly (Papilio Cardamines).
Meadow Brown Butterfly (Papilio Janira).
Currant Clear-wing (Sphinx Tipuliforme).
Ghost Moth (Phalæna humuli).
Great Egger Moth (Phalæna Roboris).
Great Tiger Moth (Phalæna Caja).
Dart Moth (Phalæna segetum).
Gyrinus natator.
Dytiscus circumflexus.

7.—The Expanding of the first Fronds of Ferns.

Polypodium dryopteris.
Polystichum aculeatum.
„ angulare.
Lastrea dilatata
Athyrium filix fœmina.
Lastrea filix mas.
Scolopendrium vulgare.
Cystopteris fragilis.
Osmunda regalis.
Pteris aquilina.
Struthiopteris Germanica.
Adiantum pedatum.
Onoclea sensibilis.
Polystichum acrostichoides.
Cyrtomium falcatum.

8.—The Flowering of Grasses.

Gynerium argenteum (Pampas grass).
Anthoxanthum odoratum.
Alopecurus pratensis.
Aira cæspitosa.
Dactylis glomerata.
Cynosurus cristatus.
Arundo phragmites.
Holcus lanatus.
Arrhenatherum avenaceum.
Briza media.
Briza maxima.
Bromus mollis.
„ sterilis.
Stipa pennata.

9.—Miscellaneous.

Swarming of Bees.
Spawning of Fish.
Spawning of Toads.
Spawning of Frogs.
Mushrooms.

The following example, selected from the climate of Nottingham, will illustrate the manner of using these observations:—

The Apricot (Armeniaca vulgaris) var. Moor-park, came into bloom—

1844 . .	March 15	1848 . .	March 27
1845 . .	„ 28	1849 . .	„ 20
1846 . .	February 26	1850 . .	„ 8
1847 . .	March 19	1852 . .	„ 13

The meantime of flowering is March 16, the range being 31 days. In 1852 the period was three days earlier than the average.

E. J. Lowe.

Highfield House Observatory.

WONDERS OF A STAGNANT POOL.

After long confinement to the house, whether from illness or an unusual pressure of engagements, how delightful to turn out for a stroll in the fresh pure air! Unheeded whether it rain or shine, if a naturalist of the true stamp, all around seems to welcome him, and care and trouble for the time fly far away. It was early in the morning, recently, that, in urgent need of a breath of fresh air, we started for a walk before breakfast; rain had fallen heavily during the night, and the air was still reeking with moisture. One trouble, and one alone, was ours during the walk—What shall we contribute to our readers in the next Recreative Science? One subject we had given much time to presented so many new features requiring careful and prolonged examination, that it had to be left for further time and opportunities; so on in meditative mood we walked, till our thoughts turned to the teeming abundance of the lower classes of vegetable life, and the important part they play in the grand scheme of life on our globe.

Coming, then, to a stagnant, fœtid ditch, our attention was caught by the unusual quantity of a blackish-green slimy-looking substance, at the bottom, sides, and floating on the top by means of entangled air. Some of this was gathered. A similar material by the side of the road, left by a now dried-up rain-pool, furnished another gathering, each, for lack of a better means of conveyance, being placed in a bit of paper, and transferred to the waistcoat-pocket. A little further on the palings, the trees, the very walls in parts, were covered with a bright green powdery-looking substance, as if they might have been recently painted, some of which was carefully scraped off; and, lastly,

nearly at our own door, we find on the gravelled path, at the base of the wall, a lively crisp-looking little vegetable, some of which is secured, and we have material enough for some hours' careful examination, and, if time permitted, months, it may be years, of study.

Let us take out the microscope; some slides and thin glass-covers, and a tumbler of clean pure water, will be wanted; and it may be as well to have a little bottle of glycerine, and another of asphalte varnish, for the preservation of the subjects of examination. The magnifying power required will be tolerably high, say about two hundred diameters. We will take a little of the material obtained from the pool, black from the close crowding of the little threads composing it, remove it with the point of a penknife to a slide, and then put on a cover. In the meantime, the portion from which it was taken may be put into a watch-glass, or other shallow vessel, with a little water. Raise the tube of the microscope, lest the object-glass be injured by touching the slide or the wate

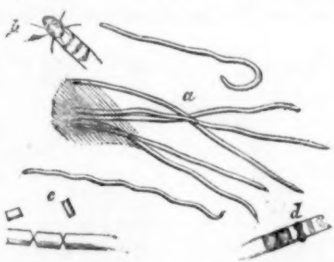


FIG. 1.—Oscillatoria. *a*, portion of a mass under a moderate magnifying power; *b*, end of one filament, with cilia (?) much more highly magnified; *c*, filament breaking up; *d*, sporange (?).

upon it, and carefully lowering it till rightly focussed, look what we have got. Why the whole field is in motion! it looks as if we had a number of little slender worms, of a pale copperas, or verdigris-green colour, uniform in diameter, and with a sufficient power and good light, bars or stripes at short intervals may be seen passing across them. Here are some that look as if they might be fastened together like a bundle of faggots, with those on the outside writhing and twisting as if they would free themselves from an unwelcome embrace. Some have succeeded in the attempt, and are passing across the field with an undulatory motion; others are imitating the action of a pendulum, whilst here is one turning what might be taken for a head, with which it would see what is going forward behind it. The peculiar character of these movements has caused the name of Oscillatoriæ to be given to the tribe (Fig. 1).

How do they move? is the first question that suggests itself, and it is not easily to be answered; for upwards of a century has it been debated, and it is yet hung round with doubts. It has been suggested by Dr. Harvey, that the appearance of wave-like flexure and oscillation may be due to onward progress in a spiral direction. This view is entertained by Dr. F. D'Alquen, in a very able article in the "Quarterly Journal of Microscopical Science" (vol. iv. p. 245), where the whole subject is treated at length, and a source of motive power described in one species, which, if the author be correct, would be, so far as known, new and unique in the vegetable kingdom, an irritable contractile fibre passing down the centre of each filament. Our own observations lead us to think that the motion is really in a spiral direction, but to what it may be due we do not venture to give a decided opinion. One observation we made, however, seems very much to the point: on doubling our magnifying power in this instance, as represented at *b* (Fig. 1), a number of fine threads were seen projecting all round the end of the filament, to one of which a minute particle of dirt adhered; we could thus see that the filament was turning rapidly round, and found it difficult to resist the belief that the lash-

ing of the water was produced by the active movements of cilia, and not merely by the passage through it of motionless processes. Such cilia, if indeed they be so, may occasionally be seen on other parts of a filament, and the most rapidly moving specimen we ever met with was furnished with them in unusual profusion. Before finally putting this down, let us add a drop of chloroform; the motion is instantly stopped, and laudanum produces a similar effect.

What relation is borne by Oscillatoria to other plants is yet a mystery. If we look at the dried-up material taken from the gravel path, it will be found to be motionless, in much shorter pieces, and those contained in gelatinous tubes; the same thing evidently, but in a different state. As it would have been impossible, before the changes had been observed, to predicate that from an egg, a motionless speck, should come an active, voracious caterpillar, which should turn again to a quiescent chrysalis, and whence should emerge at last a graceful volant denizen of air; so, till all the changes involved in the life-history of this simple vegetable are known, we are unable to say what phase the motile stage we have been examining may represent. Probably, when the pools or damp places it inhabits are slowly dried, it assumes the altered form with investing hyaline tubes; when quickly dried, each filament breaks up into its component joints (*c*), which are probably analogous to the buds of higher plants. Sometimes we find a portion assuming a different appearance, enlarged and thickened (*d*), with spaces on each side of it bare of colouring matter—such may be a sporange, or reproductive body; and there are good grounds for thinking we know but the caterpillar state, the connection of which with its perfect condition remains yet to be traced. To any who have taste for such an investigation, a rich reward in continually renewed interest may safely be promised, and it may be their good fortune to add another leaf to our yet most scanty knowledge of the "Book of Nature."

The "green stuff" from the paling is a plant of another kind; like little beads of a rounded or oval form, and delicate grassy green colour (Fig. 2). Generally each little "bead" is

Fig. 2.

free, sometimes two may be seen united, and occasionally four or six in short strings. If this be really a unicellular plant; if each of these little "beads," or "cells," as they are termed in scientific language, be really a plant in itself,

"Totus, teres, atque rotundus,"

(which may be freely translated for the occasion, "perfect, round, complete in all its parts"), it surely must, as the late lamented Professor Henfrey said, be the most numerous in individuals on the face of our globe. But it requires to be grown and watched, varying

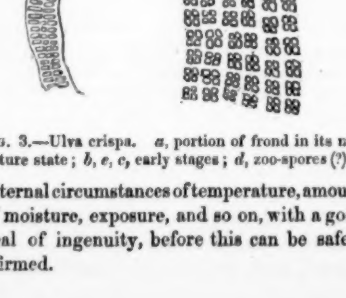


Fig. 3.—Ulva crispa. *a*, portion of frond in its mature state; *b*, *e*, *c*, early stages; *d*, zoo-spores (?).

external circumstances of temperature, amount of moisture, exposure, and so on, with a good deal of ingenuity, before this can be safely affirmed.

The little "Ulva crispa," gathered last, is always a favourite object (Fig. 3) with its bright green endochrome dotted with a charmingly regular irregularity over the delicately transparent membrane of the frond. With the mature plant may often be found narrow flat threads as at *b*, which show in an instructive manner how a broad leaf-like expansion may be formed by repeated cell-divisions, now in a longitudinal direction and then in a transverse direction. Some of the pretty bright green cell-contents have escaped, and taken on an active animal-like existence, as at *d*. The specimen from which our figure was taken swarmed with them, and though we did not actually witness any of them escaping, such has been seen. Numerous Euglenæ (Fig. 4) occurred with them, of

Fig. 4.—*a*, motile; and *b*, resting condition of Euglenæ.

which all that can be said here is simply to stimulate inquiry; though so thoroughly animal-like in their movements, altering their shape continually as they move over the field, vibrating the little whip-like cilium or two with which they are furnished—with their little red eye-like speck, and at some stages of their existence a small vesicle dilating and contracting at intervals heart-like, yet these are now known to be only motile spores (the name given to bodies analogous to seeds produced by non-flowering plants). The stages of growth of Ulva are not yet fully known, and it seems possible that the Euglenæ forms found on this occasion with the Ulva might be motile spores of the latter.

Having sought to attract to the study of these humble plants, by showing how elegant their appearance is under the microscope, how instructive the little we yet know about them, and how much of yet greater interest remains to be learnt of the history of their life, let us briefly glance at the important part borne by them in the economy of Nature. In poesy, the intensified and spiritualized reflection of the popular mind, mistaking the cause, it is held that they are pernicious in their effects.

"Mantled o'er with green,
The stagnant pool,'"

is a familiar representation of all that is fœtid and unwholesome. But is it indeed owing to this green vegetation that such is the case? Nay, on the contrary, the very opposite is the fact. Is there such a collection of foulness? Borne on the four winds of heaven, at once the Oscillatoria and allied types of vegetation appear to commence their mission of usefulness to man. Look at the portion left in the watch-glass: the spot where it was crowded together, a shapeless, unsightly substance, is now deserted, and instead, it has wormed its way to the extreme edges of this miniature collection of water, the ends all pointing outwards, as they would go further "'an if they could." Even to the naked eye, it is now a pretty spectacle, the threads forming a delicate green fringe round the margin of the glass. Thus, in the pools they spread, increasing with amazing rapidity, feeding on agencies destructive to our life, oxygenating the water, and through it the air in the neighbourhood of which they grow. By their decay a soil is formed for plants of a higher type and with higher powers of usefulness. But let us, especially the dwellers in great cities, forget not how much we owe to the unthought of agencies of "that green stuff," in revivifying the "used-up" atmosphere we are compelled by the circumstances of position to breathe, and let us not again attribute to them, our friends, ill effects which they are incessantly doing their utmost to counteract.

TUFFEN WEST.

WAYSIDE WEEDS AND THEIR TEACHINGS.

IN SIX HANDFULS.—HANDFUL II. CONCLUDED.

We now turn our attention literally to the business, or at least to the flowers, in hand. We have found that they are many-petaled, and that petals and stamens by their attachment to the calyx afford us a character which is a common bond of union; but after this, we must confess, we cannot show you any great resemblance. Vetch or pea tribe, rose or apple tribe, and hemlock tribe, to say nothing of saxifrage and willow herb, are not very similar.

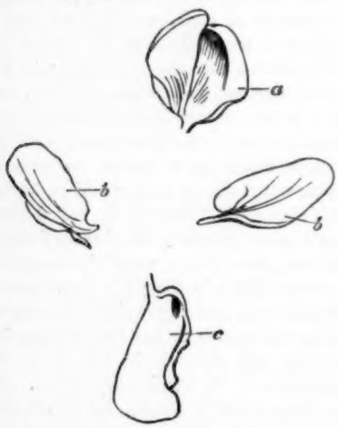


Fig. 31.—Petals of Common Broom, separated. *a*, standard; *b b*, wings; *c*, keel.

Pull this broom to pieces; it is an excellent example of its order. Off come its petals one by one (Fig. 31), and an irregular lot they look. In truth, the pea-flowering tribe, in this country at least, has very irregular flowers, by which we mean that they can only be divided one way into two equal halves. You pull off the petals and the stamens remain (Fig. 32), and there they will remain, even long after the flower has withered and fallen, as we see in the example (Fig. 33). Look closely at the stamens (Fig. 32) after detaching the petals.

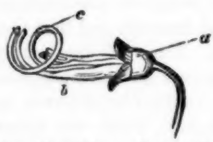


Fig. 32.—Calyx and essential organs of Common Broom. *a*, calyx; *b*, stamens; *c*, curved style.

You will perceive they are all joined together at the base by their filaments, and surround, as it were, the pistil which in the broom (Fig. 32) has a peculiar curve. This pistil enlarges into the seed-pod or legume (Fig. 33), and from this form of seed-vessel the whole of these vetch and pea plants have taken their family name of Leguminous Plants; albeit they have another name, taken from the fancied resemblance of some of the pea-blossoms to a butterfly, and hence they are sometimes called Papilionaceous Plants. The peculiar form of these butterfly-like petals has procured for them the names which are appended to the figure. You can scarcely

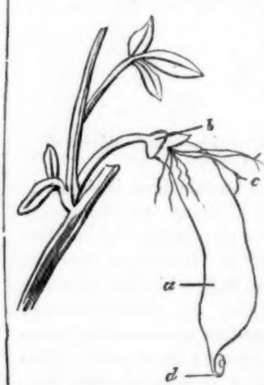


Fig. 33.—Pod or Legume of Common Broom. *a*, legume; *b*, persistent calyx; *c*, remains of stamens; *d*, remains of stigma.

see one of these leguminous plants again without knowing its social status in the botanical world, and recognizing it as a member of a most important family—quite one of the most so in Flora's kingdom. Most important to man, seeing that from it he draws such a vast number of articles which are almost necessaries to his comfortable existence. Lastly, look at the leaves of our leguminous friends (Fig. 34); but we shall speak of them in a future lesson. Suffice it to point out here that they are what botanists call compound—that they are characteristic as such, especially with the superaddition, to many, of the tendrils (Fig. 34). With distinct petals, with petals and stamens attached to the calyx, the rose tribes are grouped with our pod-bearing friends the Leguminosæ; but from them, in other respects, they differ widely.

FIG. 34.—Compound Leaf of Vetch. *a*, tendrils.

Firstly, the blossoms are regular; you can cut a strawberry, a wild-rose, or an apple blossom through the centre, in any direction, into two equal halves. Calyx, corolla, stamens, pistil, varying in divisions, number, etc., are yet all regular. You will have no difficulty with the first three sets of organs in any we have made you gather; but when you come to put the pistil, or rather pistils, of the strawberry and bramble, beside those of the apple or wild-rose, you are probably quite thrown out. The strawberry and the bramble (Fig. 29A) bear their pistils relatively to the other parts of the blossom, in accordance with your previous experience of plant arrangements; but the rose and the apple seem to put their calyx and other parts right on the top of the pistil, or at least of the seed-vessel. We are too young in our lessons to consider this subject here, and when we come to open our fruit-basket it will be fully gone into; suffice it that the difference is more apparent then real.

FIG. 35.—Compound Leaf of Rose.

however, sufficient difference to cause divisions in the great class of the Rosaceous plants; some claiming to be the true stock, or Roseæ, whilst others, including our friends the apples and pears, rank as the Pome tribe, and a third set takes their places with the cherries and plums. Nevertheless, divided or not, the Rosaceæ are a most excellent family, and are not one whit behind the pod-bearers in the amount of good things they prepare for us. We must not forget that many of them, such as the rose (Fig. 35), have compound leaves. Neither must we forget that with all the good things they give us, they are also great preparers of prussic acid, and that bitter almonds, peach kernels,

and even apple pips, contain it in abundance. True Rosaceans, however, are less given to this manufacture, and offer us astringency in its place.

Group No. 3, in our hand, greets us with the very different aspect of the hemlock tribe (Fig. 30). We find, on examination, the bond of union in the attachment of the petals and stamens, but almost all else is different. First, there is the great distinctive feature which gives the family name of umbel-bearers to this large section of the vegetable kingdom; an umbel being that peculiar disposition of the flowers which we see in Fig. 30, and which we find in all plants belonging to the order. Observe how the flower-stems all spring from one central point. You will seldom gather these hemlock-like plants with flowers otherwise than white, though some have a pinkish tinge, and one or two are yellow; moreover, we have compound leaves again (Fig 36), but compound after a dif-

FIG. 36.—Compound Leaf of Umbelliferous Plant. *a*, sheath for stem.

ferent mode from the leaves of the vetch, or of the rose; the leaf, too, sheaths the stem at its base, and the stem is more or less hollow. Look to these things, for they are part of your lesson, and then let us see to the blossoms themselves. Here, perhaps, you do not see matters quite so plainly as you did in the large-blossom plants we have hitherto examined; a little more patience is required, and the magnifying glass will aid you. Do not forget we are still among the distinct petal flowers. Five little petals have these umbellifers, placed on the top of what you will recognize as the seed—seed-vessel it is indeed (Fig. 37)—and with a calyx, more or less minute, adhering closely to the latter. On the summit of this little double seed, you will more easily make out the double styles, and the five stamens will not tax your patience much. Probably, before your examination has proceeded thus far, you will have made the discovery that the petals of this tribe of plants are by no means equal in size, and, if you have examined closely, that they have frequently a peculiar turning in—inflection—

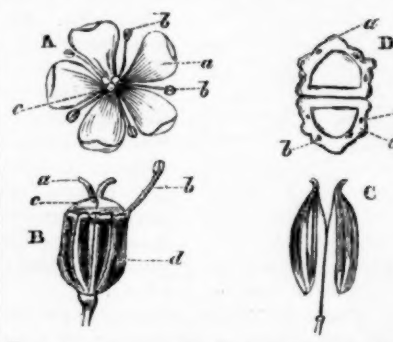


FIG. 37.—A, Blossom of Umbelliferous Plant: *a*, petal, with inflected point; *b*, stamen; *c*, pistil with double style. B, Fruit of Umbelliferous Plant: *a*, styles; *b*, stamen; *c*, a fleshy disk; *d*, double fruit. C, Ripe Seeds or Carpels separating from central axis. D, Section of Seeds: *a*, ribs; *b*, oil-channels, or *vittæ*.

at the top (Fig. 37). We could say much respecting the seeds (Fig. 37) of this extensive plant family, but that we reserve for the fruit department; only, if you have opportunity, glance at them now when somewhat

advanced towards ripening. A very cursory examination will show you how different the little, double, ribbed, and often aromatic seed is from those which have hitherto come under our notice. The caraway seed is an excellent specimen. Many drugs and aromatics, and vegetables, such as carrot, parsnip, celery, parsley, are yielded to us by the umbel-bearers.

Scarcely would it be possible to place in your hand representatives of orders of plants more important or more interesting than the triad of which we have endeavoured to give you some idea, and perhaps we could not well select orders possessing characters more likely to impress themselves upon the mind of a beginner in the study of botany.

We mentioned the white meadow saxifrage and the willow herb as included in our present handful of weeds. To such as know them by their familiar names they will offer examples of other, but perhaps less strongly marked, plant families, which still have the distinct petal character and the calycine attachment of stamen and petal. The white meadow saxifrage is an elegant plant, often found very abundantly during May, bearing its collection of white blossoms on a stem from four to six inches high, and springing from a root which seems made up of a number of bead-like granules, the size of small peas. It represents well a plant family, the Saxifrages, which contains many beautiful members, but from which man draws but little that is useful. The willow herbs are still more common than the saxifrages, and towards the end of June and in July are to be found by nearly every hedge-side—at least the smaller species with their small pink flowers. A little later, the great hairy willow herb of our ditches and ponds offers its handsome, large, rose-coloured blossoms. If you know the plants, or can find them, you will recognize the same structural arrangement of petal and stamen that we have dwelt so much upon, and when you come to examine the pistil (Fig. 38) you get another variety of the organ; for here the stigma is elegantly cleft into four divisions. The fruiting and seeding of these willow herbs are peculiar; but of that hereafter.

Fig. 38.—a, Four-cleft stigma of willow herb.

The parts of plants to which, in these our early lessons, we have more especially directed your attention, are all included in the term Reproductive Organs—that is to say, they are such as conduce to the formation of the seed upon which the continuation and reproduction of the plant species depend. The calyx, the corolla, the stamens, the pistil, make up what we commonly understand as a flower, and without a flower there can be no seed; but a botanist's flower and a florist's flower are two very different things. The florist requires gay colouring and fine petals, and cares but little for stamen or pistil; the botanist looks to the latter only as the *essentials* of *his* flower—in other words, these organs are all that are required for the production of seed, and are therefore the *essential reproductive* organs; indeed, in some plants we find no flowering beyond the stamen and pistil development.

"God might have made the earth bring forth
Enough for great and small;
The oak-tree and the cedar-tree,
Without a flower at all.

"He might have made enough, enough,
For every want of ours;
For medicine, luxury, and toil,
And yet have made no flowers."

And truth it is that we might have had all essential means of seed production without that beauty which He who made all things has lavished upon the lilies of the field. Calyx and corolla are apparently non-essential to seeding, and yet we cannot but imagine that they subserve some office of greater or less importance beyond delighting the eye.

THE CALYX

Of a plant has its first office in the protection of the flower-bud, covering the tender organs within, until their time for full expansion has come. Then it assumes various modes of procedure. We have seen, as in the poppy (Fig. 39), it may be cast off as the blossom opens, being lifted off in one piece like an extinguisher, and allowing the petals, which seem to have been crumpled up within it, to expand in their full size and beauty. More generally, however, the calyx remains for a longer or shorter time after the flower opens, and in many plants it is still there after the petals of the corolla have fallen, either protecting the growing seed-vessel, or forming part of what people generally call the fruit itself. Such we find to be the case in the apple, the pear, the thorn, the fruit of these being partly composed of the enlarged calyx. When a calyx falls off early, it is called a *deciduous* calyx; when it remains till the fruit has formed, it is called *persistent*.

Fig. 39. — Poppy-bud drooping before flowering and casting off two-pieced calyx.

As yet, our calyxes have been green or leaf-like organs, more or less regular, and easy of recognition; you must not, however, expect always to find them bearing this palpable character; they are often very irregular in form, sometimes in one piece, sometimes in two, sometimes in more. Neither is the calyx always green: of this we have had some notice in the frequently deep-coloured calyx of the wallflower, or yellow of the gorse, though, in these instances, it preserves its well-marked distinction from the brighter corolla. But there are cases where, although the corolla exists, it is so insignificant as to be entirely eclipsed by the more brilliant calyx—such we find in the hellebores or Christmas roses of our gardens; and, lastly, we find, as in the anemones, the corolla absent altogether, and its place supplied by a calyx as beautiful as any corolla. In such cases the calyx is called *petaloid* or *flower-like*. The crocus and the snowdrop likewise offer us examples of the petaloid calyx, and in such plants the entire flower, petals and sepals, are frequently called the *perianth*. When the calyx is joined together so as to constitute a one-pieced or *monosepalous* calyx, its composition of several conjoined parts is usually indicated by toothings, folding or marking, as we shall see in the primrose. Lastly, the calyx is frequently irregular in form; in this respect generally being coincident with irregularity of form in the corolla it incloses. Did space permit, we might enlarge greatly upon the variety of forms to be found in calyxes, but now that our readers can recognize the part for themselves, it is better that they should seek out their knowledge by looking at every plant or weed for that variation—and beautiful variation too—which they will not fail to find. One last word over our flower-cups. You will not have examined plants long before you meet, every now and then, with a calyx which looks rather like a collection of the ordinary leaves of the plant, than like an orderly, well-conducted calyx; this is especially remarkable among the roses and the primrose tribe, and it is, in fact, an effort of the calyx to metamorphose itself back to its original leaf-type. This is a subject of plant lore, however, which, only hinted at now, must engage our attention at some future time.

Calyx first, next within comes the corolla, regular or irregular in form, in many pieces or petals, as we have met with hitherto, or in one piece as we shall come upon it ere long. Now, before we take the flower in its full expanse of beauty, let us give short attention to it whilst yet in its

baby state, cradled within its calyx. Take any common flowers or weeds you know, or, for that matter, that you may not know, by name; open their buds—tear them open if you will, but also cut them in various directions with a sharp knife; see how beautifully packed within are these petals which, next day, or hour even, are to open in all their expanded pride, without a crease or fold upon them. These poppy petals that we spoke of a little above, look really and truly crumpled up, and yet not a trace remains of such usage. This bud-packing is known, botanically, as the *æstivation* of flowers, and the term is applicable to calyx as well as corolla, for the calyx, you will find, has its set forms of budding. Like the calyx, the corolla, when it is joined up into one piece, as it is in the primrose, the harebell or bluebell, or blue veronica, indicates its many-pieced origin by the divisions, more or less deep, which are marked upon it; these divisions bearing the same position, relatively, to the divisions of the calyx that distinct petals do—that is to say, the corolla petals or divisions are placed in alternation with the calyx sepals, or divisions, not opposite. Mark the fact, as we shall have to return to it.

The forms of the corolla are exceedingly numerous; the crucifer or cross-like, the papilionaceous or butterfly-like, the rosaceous we have already seen, but to these we must add the labiated, as we shall see it in the common white nettle, the bell shape of the bluebell, the wheel shape of the forget-me-not, and the strap-shaped little florets of the dandelion, or of the white ray of the daisy. Moreover, as if height, colour, and varied and lovely form were not enough, you will find many a blossom ornamented with other appendages, such as hairs, glands, coronets, etc., which add to its beauty. Go and see.

Within the corolla, and, when definite in number, alternating with its divisions, in the perfect flower, we have the stamens, those important organs which, along with the pistil, constitute the essential reproductive organs. You have already examined common plants enough to be aware that the stamens are not by any means definite in number, but occur in every proportion, from the many of the buttercup or rose to the few of the wallflower or the umbellifer. If, however, varied in number, they are far from being so in form; and their two component parts, the filament (Fig. 40) and the anther, are constant. The filament, or support of the anther, may be absent without injury to the utility of the organ; in other words, the anther is the essential part. Examine it attentively, using a lens if possible. You will quickly see that all but invariably this anther is composed of two valves; and if you extend your observations, you will see that from each of these valves, which are in reality little pouches, is discharged a fine yellow dust. Shake your flowers over a dark surface, and if the anthers be ripe, this pollen dust will come out in a golden shower. Dust it looks, but dust it is not; for if you get it sufficiently highly magnified, you will find it to consist of multitudes of minute bead-like grains, generally round, but sometimes oval or triangular. When ripe, shaken or not, the anthers discharge their pollen by a regular mode of opening, or, as it is called, *dehiscence;* this opening, in most cases, taking place along a line of *suture*, but in some instances by means of pores or valves. The very abundance of the pollen contents of these anthers testifies to its importance; without it, plant perpetuation does not take place. But before we get upon that subject, we must make further acquaintance than we have done yet with the other essential organ of reproduction, and for this we must look to the centre of the flower.

FIG. 40.—Stamen. *a*, anther; *b*, filament; *c*, pollen.

THE PISTIL

Is the central organ of the blossom, the seed-bearer. You will find, indeed you must have found already, the pistil much more varied in form than the stamens. In the buttercup it is made up of many members; in the poppy it consists, apparently, of but one; in the leguminous plants of one; in the umbellifers of two; in the rosaceans apparently of one in some cases, of many in others. In short, there is no end to the varieties of pistil, and such you will find the case as you go on examining blossom after blossom, as of course you will do. This seed-bearing, seed-developing pistil is composed of three parts—the ovary or seed-vessel, the style, and the stigma. Of these two are essential, the stigma and the seed-vessel; but the style, though usually present, may, apparently, as in the poppy, where the stigma lies close upon the top of the ovary, be dispensed with. Indeed, the style, like the filament of the stamen, appears to be simply a mechanical addition to essential parts, to fit them for their relative positions in the blossom. As you will find, in a future lesson, the entire plant is covered with a thin skin, or *epidermis*, as it is called; and only at one point is this wanting, that point being the stigma of the pistil, which, instead of epidermis, is coated with a glutinous matter, to which adhere the grains of pollen as they are discharged from the anther. The adhering grains convey to the ovules within the seed-vessel the power of becoming perfect seeds, for it is a rule, seemingly without exception, that if there is no pollen, no seeds are formed. In the majority of plants, the stamens and the pistils are found combined in the same blossom; but in some, such as the lychnis, which we gathered into Handful No. I., they are not only in separate blossoms, but in separate plants, perhaps widely separated. Is it not a great chance that the pollen of the one blossom reaches the stigma of the other? If it depended on chance it would be; but He who separated the blossoms has made also the provision that they do not bloom in vain. Watch that bee who is coming away from the stamen-bearing lychnis flower, and carrying with him a golden embroidery of pollen; why, the very next thing he does is to fly off to that blossom which is waiting for it, and rub his spangled jacket against it. Neither is it bees only which are the pollen carriers, for other insects, doubtless, are equally useful: and there exist well-authenticated instances of pollen thus being carried many miles to its destined use.

FIG. 41.—Pistil of primrose. *a*, stigma; *b*, style; *c*, ovary.

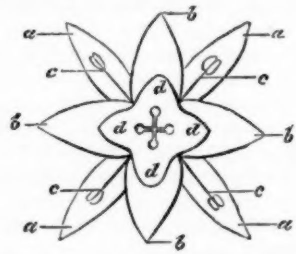


FIG. 42.—Diagram of a perfect flower. *a a*, calycine, or external whorl, of organs alternating with *b b*, corolline whorl; *c c*, staminal whorl, opposite calycine divisions, alternate with corolline; *d d*, pistilline whorl, opposite corolline, alternating with staminal and calycine.

Remember, however, that the pollen of a rose will not fertilize a wallflower, nor that of a hemlock a poppy; like must to like, and that it will to like makes it needful for the seed-grower and nurseryman to be very careful in his way. Allied plants, such as cabbage, cauliflower, broccoli, etc,, do intermingle in their fertilization, and as a consequence a choice variety may be deteriorated or lost by the flowering of other varieties of the same family in its immediate neighbourhood. However, this is digression. To go back to the stigma and its varied forms; we

have already alluded to the four-cleft organ of the willow herb, now look at the harebell or campanula, and it is three-cleft; find it out in the grasses, and it is an elegant feather; in the primrose, a little knob like a pin's head.

We have already remarked that the organs of the flower were *essential* and non-essential with reference to the production of seed, the essential being the stamen and pistil. Nevertheless, the botanist regards that blossom only which possesses all those parts regularly developed as the type of a perfect flower; a lychnis wanting in one blossom the pistil, in another the stamens, or the anemones with a petaloid calyx instead of corolla, are not perfect flowers, botanically speaking. Be it remarked, too, that not only must these parts be present, but they must be developed in a regular series of circles, or *whorls*, as they are called, the organs alternating one with the other; the corolla divisions alternating with those of the calyx, the stamens with the divisions of the corolla on the one side, and with the parts of the pistil on the other (Fig. 42) These relative positions are, of course, altered by variations in number and development, but still they afford to botanists a standard by which to judge in the determination of doubtful parts.

SPENCER THOMSON, M.D.

A PORTABLE EQUATORIAL.

WE may presume that every person who can distinguish between the stars Sirius and Polaris, knows what is meant by an equatoreal. However, as it is often well to place the chief design or principle of a thing prominently before the mind, when reference is made to the details, we hope to be forgiven if we begin at the beginning, and describe the instrument as one by means of which a telescope can be directed to any point in the heavens; and then, by the reading of two graduated circles connected therewith, the exact relation of that point in degrees, minutes, seconds, and fractional parts of seconds to the pole, the first point of Aries, or to any other point, can be ascertained with great precision.

Further, an equatorial of the first class is so connected with clockwork, that the telescope can by it be made to follow a fixed object above the horizon during the whole of its apparent diurnal motion.

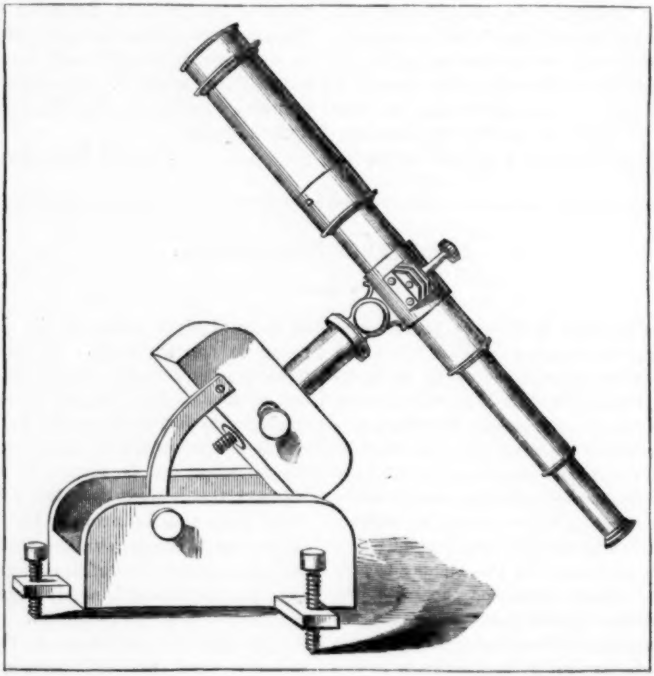
Imagine a vertical shaft, with a telescope attached to it, so as to allow the telescope to move at right angles to the shaft, on a round axis in the shaft. By turning the telescope, the complete tour of the horizon can be made. Imagine a motion at right angles to the former or parallel to the shaft, and it is obvious that by these two motions the telescope can be turned to any point between the horizon and the zenith, if a slight projection be made in the part connecting the telescope with the shaft, so that the latter shall not interfere with the former, when the instrument is nearly vertical.

But this is *not* an equatorial.

Now *tilt* the instrument, so that the at present vertical shaft shall point to the pole, or, in other words, be parallel to the axis of the earth. The instrument becomes an equatorial. It may be the magnificent instrument at Liverpool, probably, in mechanics, the *chef d'œuvre* of the Astronomer Royal; at all events, till the erection of the very recent one at Greenwich Observatory (see *Athenæum*, June 11, 1859, p. 777); or it may be our own plaything, the telescope belonging

to which can be put into the coat-pocket, and the stand into a small carpet-bag. The main principle is the same in both.

To describe the latter is the object of this paper. The design of the former class of instrument is to ascertain, with great precision, the place of any celestial object, for purposes which it would not accord with the intention of this paper to explain; the design of the latter is simply to *find* an object in the heavens (without having to *fish* for it), this being done by the setting of the circles attached thereto by means of moderately well-divided graduations.



Suppose a comet to appear. The owner of such an instrument reads in the public prints that at such and such a time the *right ascension* of the comet is so many hours, minutes, and seconds, and the *declination* north or south, or the *polar distance* (which can be converted into *declination*, and *vice versâ*), is so many degrees, minutes, and seconds of arc. By a simple calculation, with the aid of the Almanac, the observer knows when the comet will be on the meridian; and hence, at any hour before or after that time, he knows how far in hours, minutes, and seconds of time, or degrees, minutes, and seconds of arc, it is from the meridian. The error of his watch or clock having previously been ascertained within a fraction of a minute, a nicety sufficient for the purpose in view, he proceeds to set the telescope, by means of the graduated circles, to a given

time and to the given declination; and having verified all the steps of the process, he looks through the telescope with the certainty that the object—the comet, star, or planet, etc.—is in the field of view, whether visible or not.

With a telescope such as the one last referred to, it is not likely that a *comet* will be visible in the day-time; but Venus, Jupiter, or stars of the first magnitude, can be seen in broad day-light, if the sky be clear. They will often appear exceedingly faint; but there they are, their apparent places in the heavens having been found by the circles attached to the instrument, and not by *sweeping* the heavens.

The instrument which it is the special object of this paper to describe, was constructed by the writer for his own amusement; and a great number of trials have proved that its design, that of insuring the presence of the celestial object somewhere in the field of view, can always be accomplished.

Let not astronomers smile at the roughness of the instrument, till they are told that the graduated circles by which the instrument is directed to an object are not so much as *one inch* in diameter, and that the divisions were cut in brass by the hand of an amateur.

The history of the instrument is as follows:—In the year 1850, a friend of the writer was amusing himself in constructing an equatoreal mounting for a two-inch refractor, according to a design of his own. He was a good mechanic; but having chosen *wood* (which he thought would do for this rough purpose) as the material upon which to fix his graduated circles, carefully executed on paper, he met with an unsatisfactory result, which the writer predicted would be the case. It occurred to the latter to attempt to divide the brass circles on a "clip," used for attaching the telescope to a post, or otherwise, by means of a screw connected with it, the "clip" having the two motions already referred to. The graduation was a work of considerable labour; but, besides the advantage of making use of an article already possessed, the plan had several advantages connected with the smallness of the diameter of the circles, to be set against the disadvantages. The result was very satisfactory. The graduations were tested by the sextant, and were found to be sufficiently good.

Amateur astronomers will enter into the feeling of boyish delight with which the first finding of Venus in the broad day with the instrument was associated. The writer would have been amply rewarded for his pains, if the pleasure which the exhibition and explanation of the little instrument has given him since the time referred to were his sole reward.

Among those to whom he has shown it, and who have expressed themselves as highly pleased with the instrument, the writer is proud to refer to a lady whose interest in astronomy, and whose powers of exciting an interest in the study of this glorious science in others, have lately been so pleasantly exemplified in the little gem called "Telescope Teachings."

WILLIAM C. BURDER.

Observatory, Clifton, Bristol.

STEREOSCOPIC PHENOMENON.

I WAS amusing myself one evening with a stereoscope, and, having exhausted my stock of stereoscopic pictures, I placed in the instrument a small photographic portrait, about three inches by two, and as nearly as possible in the centre, so that one-half was visible to one eye, and the other half to the other eye, and was surprised to find on looking at the picture, with both eyes open, that that side which could only be seen by the right eye appeared to be seen by the left, and that seen by the left eye appeared to be seen by the right. I submit the case to the consideration of stereoscopists, in the hope of obtaining an explanation. STEREO.

JOHN SMEATON—A LIFE AMONGST THE LIGHTHOUSES.

WHAT BIOGRAPHY SHOULD TEACH.

It is the fashion now-a-days, and a good fashion it is, to explore God's ways in creation. Especially with the lower forms of life, has science been explanatory. Within the limits of the knowable, we all seek to understand everything; we wish to see demonstrated—

> "How every small ephemeris sets forth
> Purpose and science, if born but to die."

And it were well if we carried this desire somewhat further, and extending our inquiries, learned that God not only fashions a diatom, a moth, or a mammoth for a purpose, but that for His good ends also, He fashions the muscles of the worker, and moulds, with Almighty touches, the brain of the thinker. Yet this is true. The true object of biography, in tracing the conduct of an individual is, according to Coleridge, to show clearly what result his active life has produced on the well-being of his fellow-men, and also what is his position as one of the "great landmarks in the map of human nature." It is yet more: the true biographer, whether in a sketch or in a volume, ought to show what inner and higher impulses filled the man—in what he differed from his fellows in being prominently set aside for his work; how the man of science, no less than the warrior, the lawgiver, the poet, or the sage, was expressly singled out for one purpose, and how that purpose being fulfilled, he waned and died out, and went to the grave, where no thought can stir the still brain, nor work move the stiff sinews of the dead hand.

Perhaps this overruling purpose is better and more clearly seen in the lives of men of science than in any other biography. Davy, Ferguson, Newton, Stephenson, Smeaton, each and all had an impulse which no one could restrain, which adhered to them through life, and left them only in death. In John Smeaton's case let us hasten to prove it.

HIS BIRTH AND INFANCY.

On a May morning—rather when May was lapsing into June—and at a little Yorkshire village, in 1724, John Smeaton was born. The family had planted a firm foot in Yorkshire; grandfather had built the house there, and father was a "respectable attorney:" so write the biographers, presuming, of course, that attorneys can be respectable, upon which Smeaton ever had his doubts, and the present writer does not offer an opinion. John hated the attorney's desk. Engrossing was not his pursuit, but, unlike the clerk in Pope's well-known lines, he did not pen a stanza, but he drew a plan of some piece of machinery. He was eminently constructive. A little fellow in petticoats even, he disregarded toys, save as machines. He could set the leg of a Dutch doll, and then he would away with it; but he loved to watch the millwrights, and those who drew water from the well, or put in action the simple machinery of the pump. He went home after such an exhibition, and made a working model out of an old piece of bored pipe. He also, greatly to the terror of his friends, for he was then about six years old, made a working model of a windmill, and mounted the highest barn his father had, to fix it. At fifteen, he had constructed an engine to turn rose-work, and gave his friends boxes in wood and ivory as specimens. Clearly he was not born to serve a writ, or to issue a distringas. Good Mr. Holmes, in 1742, visiting his father, sees this, and is wonderstruck at the young mechanician. He forged his iron and steel, melted his metal, fashioned every tool to work with.

Amongst other things, he turned out a perpetual screw, then little known, and by indefatigable industry, was so good a mechanic, "that," says Mr. Holmes, "few men could work better." But for all this, he is to be a lawyer.

SMEATON AT THE DESK.

Not only mechanics, but the works of that Heavenly Mechanician whom we should all study, became subjects of this honest young Englishman. Nevertheless, in 1742, his father sent him to London to attend the courts, and to practise the law. For a few terms he did so, and then, yielding to the bent of his genius, he memorialized his father. John Doe and Richard Roe were not for him. Law puzzled him, but he was clear enough upon mechanics. He told all this in so persuasive, honest, and truthful a way, that his father saw the necessity, and agreed to the transfer. Law lost one honest man; society gained so much, that to this day we reap the benefits thereof.

Smeaton continued to live in London. There he found food for his genius. He commenced the business of a mathematical instrument-maker in 1750. A year afterwards he made a machine to measure the ship's way at sea, also a peculiar compass, and took two voyages to test these inventions. In two years from this he was elected Fellow of the Royal Society, and enriched their "Philosophical Transactions" with his papers.

SCIENCE AT LAST.

The little boy who in his pinafore made a windmill, and invented a pump, still turned his attention to wind and water. These were the two great motive powers, for as yet steam was but infantine, and much unknown and mistrusted. In 1759, Smeaton was adjudged the gold medal of the Society, for his inquiry into the powers of these two forces. He was, however, soon to experience these two united against his own work, to find them, not the friend of man, but his worst foe. "Fire," says the old proverb, "is a good servant, but a bad master." Cruel and wasteful it is, a tyrant of the worst sort; but not worse, nor more destructive to human life, than the winds and waves, when the one lashes the other into fury.

In December, 1775, fire had a great mastery over the Eddystone Lighthouse, and it was burnt down. The Earl of Macclesfield, who had always been friendly to Smeaton, recommended him as the best man in England to build a new one, and he undertook it. "You must," said he, "build it entirely of stone. Rudyerd and Winstanley have failed; but what then? Their houses wanted weight. Ours must not only be founded on a rock, but must press and grow upon that rock." Upon this principle he proceeded. The first actual work was done in August, 1756; new steps were cut in the rock, massive stones were dovetailed together, and Smeaton himself experimented on cements until he found one that would resist the action of the water, and would, under the most adverse circumstances, grow consistent with and adhere to the stone, and form one solid mass. At the latter end of September he and his men quitted the rock, and it was not till June in the following year (1757) that he renewed his work. The whole story of the building of this lighthouse is one of difficulty and of danger, and of these being overcome by determination. The winds and the waves did their worst; but Smeaton's house was not only founded on a rock, but had become amalgamated with the rock itself. Storms beat angrily against it—storms as great as that which carried away the hapless Winstanley and his workmen, and yet it stood, and stands. He who would behold Smeaton's great monument should journey to the Eddystone; others there may be larger and more recent, but the downright English principle of Smeaton's work is the foundation of all enduring works of that kind.

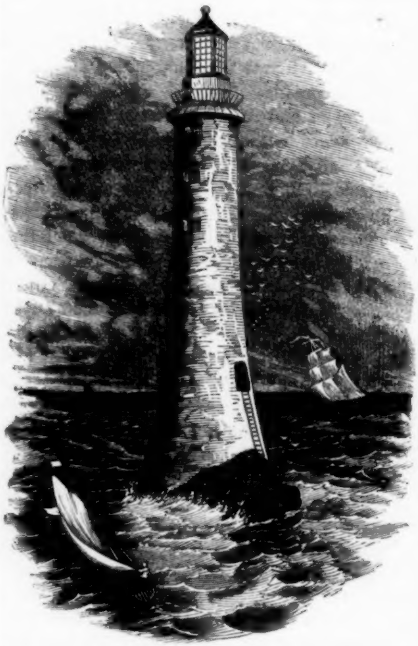
SMEATON'S LOVE OF HIS WORK.

When the Eddystone had grown to a good level, so that the engineer could walk about, he took such pleasure in his work that he walked backwards and forwards surveying it, till, stepping backwards, he fell over the rocks, and might have killed himself, but happily escaped with only a broken thumb. No aid being near, he set it himself; but the thumb plagued him sorely for a year. In August, 1758, the fourteenth course of stones, and what was called the fundamental solid, was completed; and thenceforward greater care was necessary, as the centre stone was omitted, and the hollow pillar for stairs, well-hole, and entry-door was commenced. Throughout the winter the work stood solidly, and in another year the twenty-eighth hollow course, surrounded with iron chains of great strength lying in grooves cut in the stone, into which was poured molten lead, was completed. Then commenced the building of rooms for the keeper and his assistants. The winter of 1758-9 Smeaton spent in London, preparing everything for his work. In March, 1759, there was a great storm, and much damage was done at Plymouth. To Smeaton's delight the lighthouse was found unharmed, with the workmen's tools lying in the same places as they had left them in the last year.

On Friday, August 17th, 1759, the column of the lighthouse was completed. It contained forty-six courses of stone, and rose to the height of seventy feet. The top was finished with a gilt ball and cupola, and every precaution was taken that the beds of the keepers should be free from damp, and that the spray of the sea should not penetrate the frames. Of the lighting of this house we have nothing to say here; the process deserves a separate notice. The labours of others have since made perfect the reflection from the celebrated building of Smeaton.

FAME AND FORTUNE.

Little more than one hundred years ago, on the 16th of October, 1759, the lights along the shore again beamed forth from the Eddystone, a warning and a guide to the toil-worn mariners. Smeaton's satisfaction at the completion of the work was intense. The boy in a pinafore had felt a wondrous triumph in



his miniature water-mill. As fresh and as beautiful were the feelings of the man of forty at the completion of his great work. He slept in the lighthouse, sailed out to sea and viewed it, gazed at it from a telescope from the shore. From the garrison of Plymouth he watched it in a storm, and the sight was grand. "A combination would happen," he says, "when an overgrown wave would strike

the rock and building conjointly, and fly up in a white column enwrapping it like a sheet, rising at least to double the height of the house, and totally intercepting it from sight; and this appearance being momentary, both as to rising and falling, one was enabled to judge of the comparative height, by the spaces occupied in the field of the telescope by the column of water and the house." The year closed with tremendous storms, and the courage of the light-keepers was tested to the utmost. For twelve days the sea ran over them so much that they could not open the door of the lantern, or any other door. "The house did shake," said one of the light-keepers, "as if one had been up a great tree. The old men were frightened out of their lives, wishing they had never seen the place. *The fear seized them in the back, but rubbing them with oil of turpentine gave them relief.*"*

Great as was the fame which this work gave Smeaton, it did not immediately bring him constant employment, but that came at last. In 1764 he became one of the managers of the Greenwich Hospital estates, and by his tact and diligence greatly improved the property, so that in ten years afterwards, when he wished to resign his post, he was induced by solicitation to retain it, so much were his services held in esteem; but in ten years, from the time we have mentioned, Smeaton was regarded as one of the foremost men of his day.

WORKS AND CHARACTER.

Close observation of natural laws, of the place, of the thing to be done, of the very best practicable manner of doing it, seems to have been Smeaton's leading characteristic through life. His chief works were, in addition to the Eddystone, lighthouses at Spurnhead, at the mouth of the Humber, a new bridge over the Tay, at Perth, the laying out of the great canal connecting the Forth and Clyde, the rendering of the Calder navigable, and the propping of the centre arch of London Bridge, and the pier and harbour of Ramsgate. He was consulted upon every difficult engineering point, and the hints and wise suggestions which he gave were innumerable, and he may in some sort be regarded as father of a long and brilliant line of English engineers, men whom no difficulty could daunt, nor any obstacle throw back. The last great work of Smeaton was the Ramsgate pier and harbour, which was finished in 1791, thus providing a harbour of refuge for ships storm-pressed in the Downs. Then his work was done. He was very anxious to write an account of his labours, commenced it indeed, and has left us a record of Eddystone. On September 10, 1792, he was seized with paralysis, and within a month and twelve days he died, aged 69. Falling into the hands of Death, Smeaton was resigned, faithful, and brave. He had been a good man through life. "I conclude myself," he says, in one of the last letters he dictated, "nine parts dead, and the greatest favour, I think, the Almighty can do is to complete the other part." He dreaded also senility and a loss of faculty, "lingering," as he expressed it, "over the dregs after the spirit had evaporated." As he lay upon his bed, upon one moonlight night, he looked up to the purely resplendent orb, and said, "How often have I looked forward to the time when I shall see vast and privileged views of an hereafter, when all shall be comprehension and pleasure." Clearly to know, to understand the works of God was the highest pleasure of the dying Engineer, as it had been to the living. Throughout life he had preserved undeviating probity. His first aim was to do his best. He rejected many lucrative appointments, rather than undertake too much. Even when his health was failing, he was so liberal of his time and advice, that he gave both to many who needed them. His highest ambition was to serve

* This banishment of fear, a powerful passion, by material means is very curious, and deserves remark.—H. F.

his country. He was not greedy of money. The Princess Dashkaw, commissioned by the Empress of Russia, offered him an unlimited reward, if he would settle in that empire, and carry out, originate, and direct the vast engineering projects, which filled, and still fills, the brains of the Czariate; his answer forms an admirable parallel to that of Andrew Marvel, who, when offered a bribe, showed the leg of mutton upon which he and his servant had dined for three days, asking whether one who enjoyed such humble fare, and was content, was likely to sell himself. Smeaton called out to the old woman who took care of his chambers in Gray's Inn, saying, "Money, and position, and grand attendants, are little to me, when this old servant suffices for all my wants." The Princess, unaccustomed to such honesty, said, "Sir, you are a great man, you may have an equal in abilities, but in character you stand single. Sir Robert Walpole was mistaken; my sovereign has the misfortune to find that there is *one* man who has *not* his price."

It was a grand thing that a simple English Engineer should, in the eyes of a foreign potentate, redeem the character of his countrymen, so falsely attacked by the prime minister of their country. The scene is worthy of a great painter, worthy also to be remembered and to be reproduced whenever English genius is solicited to desert its country for foreign gold.

HAIN FRISWELL.

THE YOUNG PHILOSOPHER AT HOME—CHEMICAL EXPERIMENTS.

AT this festive season, when red fire and blue flame add their charm to the pantomime—when the young folks are to have their "party"—when things that charm our five senses are purposely gathered together to enthral the mind, and make it love life—when the EYE is gratified with the graceful forms that flutter in the ball-room, the personification of a happy youthful dream—when the OLFACTORY nerve vibrates with a sweet smell, like a garden at evening's close, wafted from a *mouchoir* held with "unaffected grace"—when the EAR carries the sounds of music, and plays upon the heartstrings a joyful tune—when TASTE pronounces blanc-mange, custards, cream, and frangipane-pudding as the acme of "what is good"—and when TOUCH, by the clasping hands and kissing lips, tells us that they whom we have expected for "a whole year" have at length arrived;—when all these, the five acts of our Christmas drama, are enacted in one scene, we, of course, must play our part. To perform a clever experiment with dexterity before a "small party" is at once to become the hero of the evening. If you cannot sing, you must solve conundrums or dance a hornpipe; if neither of these be "your forte," a good experiment or two will give equal pleasure to the "bright blue eyes" peering on you. Remember that experiments of this kind are not only amusing, but instructive; they illustrate what at first sight appear to be "the laws of Nature reversed," while, in truth, when we are familiar with them, they teach the "immutability of Nature's laws." The more experiments a boy makes, the greater number of rounds will he ascend up the "ladder of learning;" and when he is at the top, how bright is the prospect before him! All is beautiful, wonderful, and lovely! To please the philosophic youth during his vacation, we have selected a few scenes from our chemical pantomime; so, "Here we are!"

LATENT HEAT SUDDENLY MADE SENSIBLE.

It is a common trick among boys to rub a brass button rapidly upon a smooth piece of wood, and then to apply it to a companion's cheek; the button being then "too warm to be pleasant," induces some merriment at the expense of the luckless wight who is the victim of it. The heat thus produced is a simple example of frictional heat. A somewhat similar experiment, illustrating the latent heat of amorphous antimony, leads us to a branch of "recreative science."

The slightest friction against a piece of this antimony makes it instantaneously "too hot to hold." If a small tube of amorphous antimony, like a test-tube, be filled with cold water, and then the tube be abraded with a file, so much heat will be given out that the water will boil. Small pieces of amorphous antimony held between the thumb and finger, and rubbed on any rough surface—the file of a pair of nail-scissors will do—becomes so suddenly hot, that the effect "seems like magic."

Mr. Gore, of Birmingham, discovered amorphous antimony. The following is his process for making it:—"Take two parts of hydrochloric acid, add as much oxide of antimony as it will dissolve with much stirring, and then add one more part of acid. Now pass a current of electricity from a small battery through the solution by means of an anode of antimony and a cathode of sheet copper; continue the action for two or three days, until the antimony is deposited upon the copper from one-sixteenth to one-eighth of an inch thick; then transfer the copper cathode to a bowl of cold water, bend it cautiously, and the amorphous antimony will drop off in flakes. When dried, it may be kept in wool any period for future "recreation."

A BROWN-PAPER MAGNET.

A very simple and interesting electrical experiment may be made with a sheet of brown paper, illustrating, in a remarkable manner, how the most astonishing effects may be produced by the simplest means. Take a sheet of coarse brown paper, and after holding it before the fire till it is perfectly dry, fold it up into a long strip of about two inches wide; the magnet is now complete. To exhibit its attractive power, cut some strips of writing-paper about three inches long, and as wide as the space between these lines; place them upon the table three or four together. Now take the magnet, and draw it briskly under the arm two or three times; its electro-magnetism is instantly developed, and becomes apparent when held over the small strips of writing-paper, for they fly up from the table towards the paper magnet, veritably "by the wings of lightning."

ROSIN BUBBLES

The method of making soap bubbles is sufficiently familiar not to need description. Rosin bubbles are made in a similar manner. A tobacco-pipe is to be dipped into melted rosin not hotter than just to liquefy it; when the pipe is blown through, bubbles will be formed of various sizes, from that of an egg down to a bead; and from their metallic lustre and reflection of the different rays of light, showing the prismatic colours, they have a very pleasing appearance. They generally assume the form of a string of beads, many of them perfectly regular, connected by a gossamer fibre of rosin. Unlike soap bubbles, those made in this way have sufficient permanence to bear touching with a gentle hand, and with care will remain perfect from Christmas-eve to Twelfthtide.

TO LIGHT A CANDLE WITHOUT TOUCHING THE WICK.

Let a tallow candle burn until it has a good long snuff, then blow it out; with a sudden puff a bright wreath of white smoke

will curl up from the hot wick; now if a flame be applied to this smoke, even at a distance of two or three inches from the candle, the flame will run down the smoke and rekindle the wick in a very fantastic fashion. To perform this experiment nicely there must be no draught or "banging" doors while the mystic spell is rising.

THE MAGIC EGG.

Take a pint of water, and dissolve in it as much common salt as it will take up; with this brine half fill a tall glass, then fill up the remaining space with plain water, pouring it in very carefully down the side of the glass, or into a spoon, to break its fall. The pure water will then float upon the brine, and in appearance the two liquors will seem but as one. Now take another glass, and fill it with common water. If an egg be put into this, it will instantly sink to the bottom; but if, on the contrary, the egg is put into the glass containing the brine, it will sink through the plain water only, and float upon that portion which is saturated with salt, appearing to be suspended in a very remarkable and curious manner.

CHAMELEON FLUID.

Make an infusion of logwood in the same manner that tea is made; the only precaution is, not to make it in a metallic vessel. Now pour out some of the logwood-tea into four wine-glasses; to one of the glasses add a few drops of vinegar, to another put in a few grains of alum, and into the third glass a few grains of green copperas (sulphate of iron); in the fourth glass the liquid may be left of its natural colour, while the three former will be changed respectively into red, blue, and black. An infusion of red cabbage will change in the same manner, and becomes green by the addition of a few drops of hartshorn, *i.e.*, ammonia.

COLOURED FLAMES.

Few experiments are more interesting to the young philosopher than the production of different flames. The best material for burning to exhibit these effects is spirits of wine, the substances to produce the colours being previously dissolved in it. Thus, to produce a greenish-blue flame, put into a vial a table-spoonful of spirit, and then shake in two or three pinches of sulphate, nitrate, or chloride of copper; twist a piece of lamp-cotton round the end of a wire, and dip it into the mixture; then set it on fire, and the beautiful colour is at once produced. For a pale-yellow flame, put into the vial of spirit a tea-spoonful of common table-salt. The flame produced by spirit containing salt has a very singular effect upon colours, especially red, which, if there be no other light in the room while this mystic flame is burning, appears of a blue-black. All other colours, such as the various tints of ladies' dresses, undergo a chameleon change. "Rosy cheeks" and "coral lips" are metamorphosed to a ghastly slate colour, creating much merriment. Red or scarlet flame is produced by dissolving in the spirit a small portion of nitrate of strontian or chloride of calcium. All these substances may be procured from any operative chemist. The strontian comes from Argyleshire, in Scotland, and takes its name from Strontian, the town in the neighbourhood of which it is found. There are many other substances which colour flame in a like manner, such as boracic acid, chlorate of potash, etc.; but those previously named produce the most striking effect, the colours being modified by mixing the chemicals.

INSTANTANEOUS CRYSTALLIZATION.

All experiments for the production of crystals are both interesting and beautiful; they show that all matter will assume, under favourable circumstances, a definite and regular form or shape. Crystallization is a species of vitality belonging to, and inherent in, what are generally called unorganized earthy substances, perfectly analogous to the regular

form assumed by plants and animals. A certain crystal will produce crystals of a like kind, but not of another, just as the seed of one plant produces its kind, but no other; thus:—Dissolve three ounces of sulphate of soda (Glauber salts) and two ounces of nitrate of potash (saltpetre) in five ounces of boiling-hot water; divide the solution into two bottles; in one place a small crystal of saltpetre, and in the other a crystal of Glauber salts; allow them to cool slowly, when it will be found that saltpetre only will crystallize in one bottle and Glauber salts in the other, growing up from the crystal seed that was put in. Crystallization is the first link of the chain that unites man with the "dust of the earth." The slower crystals are formed, the more beautiful and regular they appear; but as it is interesting to see them form quickly, though not of good shape, we give the following experiment, by which a liquid is made to become almost solid in an instant. Take half a pound of Glauber salt, crush it to powder, and pour upon it half a pint of boiling water. As soon as the salt is dissolved, pour off the clear hot liquor into a warm glass-tumbler, and set it in an undisturbed place. Now, as quickly as you can, put a table-spoonful of sweet oil on the surface of the solution, and let it stand till quite cold. In this state it will remain liquid, but if touched with a piece of wood, or if anything be dropped into the glass, the whole will instantaneously crystallize. If a bottle be quite filled with the hot solution, and corked up while hot, it will remain liquid when it becomes cold, but when the cork is drawn, crystals will be rapidly formed.

SEPTIMUS PIESSE.

CLOCK-WORK CHROMATYPES.

I HAVE invented an instrument analogous to the Colour-Top, giving steady revolution, easily commanded, effecting a perfect blending of the coloured radials, and, at the sametime, affording a proper focus, or point of view, from which rightly to discern the curious and pleasing effects of the groups of tints.

There is no particular rate of speed necessary for the elimination of all effects, for they become apparent as soon as the colours are made to revolve; some are produced by slow motion, while others require rapid revolution to discover their beauties. It will, therefore, be quickly perceived that the top which can only be used at a high rate of speed is limited in its application, and, by its rapidity, overshoots many combinations, which are thus entirely lost. It has also the quality of being erratic: it may, unless carefully watched, find its way to the floor, rotating upon your best corn *en route*, or it may pirouette amongst the gentle shepherds and shepherdesses we so carefully preserve under French-shades, to their disadvantage; and for evening use it is not very applicable.

My simple little machine entirely remedies these—various rates of speed are obtainable at will, the string "winding-up act" is obviated, many original and beautiful effects are produced, while a proper light may be chosen; and, as it may be used by artificial light, our friends have the opportunity of viewing the beautiful effects during the long evenings.

Upon a polished oak stand I have mounted a few wheels of an aged brass timepiece, the arrangement of which will be readily understood from the diagrams (Figs. 1 and 2).

To the topmost wheel I have fitted a piece of oak, and upon this glued a circular piece of stiff cardboard; this forms my disc-

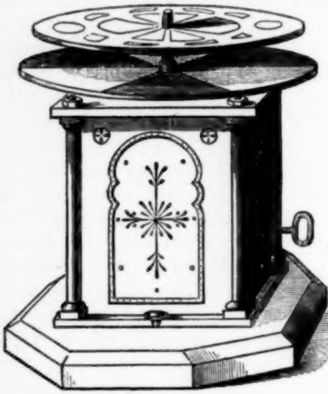


Fig. 1.

table to receive the coloured papers. Vertically to this I have adapted a boxwood spindle, with a screw formed at the bottom

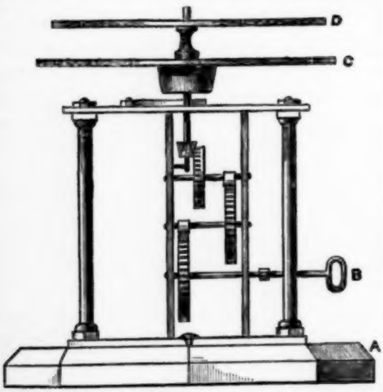


Fig. 2.—A, Stand; B, Key; C, Disc-table; D, Black pattern.

end, and shouldered at the top to receive patterns. The screw enters the oak through the cardboard, and fixes the coloured papers while revolving. To the spindle of the lowermost wheel I have fitted a pipe key, similar to those used for French clocks.

It must be borne in mind that one whole turn of this key will produce upwards of 650 revolutions of the disc-table. Here we have, then, very great power and mechanical leverage, and one also by which the speed can easily be computed, a thousand revolutions and upwards being obtainable per minute, when required, or a very slow speed may be maintained by the gentlest pressure of the key, evolving effects hitherto unattainable; so that experiments may be tried, and their formulæ speed be described to friends at a distance with a certainty of success, if repeated. The speed being continuous, a coloured plane being fixed, the variation of the colours may be observed, and disc after disc tried, shifted, and others substituted, each one being made to revolve at varying speeds, producing many effects, as almost all my patterns do; and the instrument being fixed in one place, the eye may be brought to bear upon it in its proper focal position.

There is one other disadvantage I have overcome—it is this: When a black disc is

Fig. 3.

revolving, the play of light upon it produces a certain aberration, a hazy indistinctness,

certainly not advantageous. I obviate this by an invention I call a *chromascope* (Fig. 3). This is a hollow cone, twelve inches long, five in diameter at the base, and one inch in diameter

FIG. 4.—A Beautiful Plaid.

at the apex, painted black inside. The effect of this apparatus is truly surprising when held vertically about half an inch over the

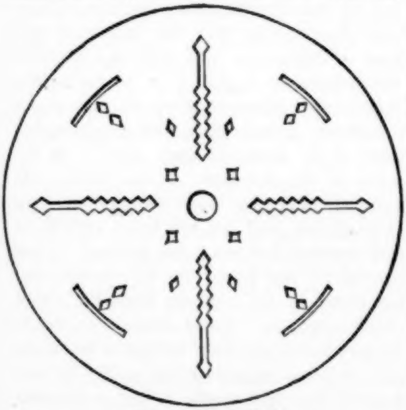


FIG. 5.—Constellation.

black disc, and the eye applied to the smaller end. All that was misty before is now clear enough; the changes and alternations may be watched with great interest and minuteness, and the colours shine out and sparkle with great brilliancy. I have made patterns which from their effect we call the "Meteor," the

FIG. 6.—Comet.

"Constellation," the "Comet," etc., and which can only be viewed, with proper effect, with the chromascope.

FIG. 7.—Open Pattern Work.

Having thus briefly described the instruments, I append a few experiments, which may be divided into classes. It may be stated

that I simply give one experiment of each class:—

1. *From simple colours to produce a compound colour.*—Take a disc coloured equally red, blue, and yellow, and placing your finger upon the red, have the blue upon your left hand, and the yellow on the right; rotate this very gently, so that blue passes the eye before the yellow; by turning the key away from you, you have a blue. Let this cease, and then *very gently* reverse the key; by turning it towards you, a WARM GREEN will be produced. The singularity of this I will not now discuss.

2. Have a disc coloured in concentric bands like a target, say blue centre, then crimson, orange, yellow, and purple; you will look for a rainbow-like blending—try.

3. *What white is composed of.*—Divide a disc, violet 80°, indigo 40°, Prussian blue 60°, green 60°, yellow 48°, orange 27°, red 45°; rotate with speed.

4. Screw on a disc, half blue half white, rotate and mount the pattern, say Fig. 4, on to the spindle. The black will gradually disappear and become *blue*, while all the perforations are *white*.

5. Put down a multi-coloured disc and pattern. Fig. 5 will produce a jewel-like constellation; Fig. 6 will give long rays of colour darting like a meteor or comet's tail, etc.

6. This is a different class of experiment. Put down a multi-coloured disc, and immediately upon it place a rather open pattern, as Fig. 7 (looping up the string), screw these down *together* and rotate—this will show a beautiful graduation of tints; then mount a pattern over all and apply the chromascope. A magnificent double and treble network or engine-turning will appear to view, varied according to the speed of rotation, as also by changing the upper pattern.

These experiments may be varied *ad infinitum*, and many others will suggest themselves to the manipulating readers of this work, from which, I have no doubt, very interesting and important results will be obtained.

All the experiments may be tried by candle-light. The yellows only becoming dull, a few self-evident arrangements will have to be made. The light must be placed nearly level with the black discs, so as not to throw a shadow upon the disc-table, and then the colours appear exceedingly brilliant through the chromascope.

Thus I will now leave the matter; but as every few days suggest to me some improvement and new use for this curious instrument, I may be able, at a future time, when I have matured my experiments, to interest others in them through the medium of this work.

Guildford. THOS. GOODCHILD.

THE APTERYX AT DINNER.

ON a worm being presented to an Apteryx, it seized it between the tips of its mandibles, and a sleight was then performed which it perfectly baffled the eye to follow. All that was seen was a sudden jerk of the head upwards, and an opening of the bill equally sudden and simultaneous; the worm meantime disappearing with the quickness of a flash of lightning. The mode by which it was swallowed appeared to be this:—The worm being taken between the tips of the mandibles, a very rapid retrograde movement of the head and neck gave it an impetus in the direction of the throat. It was held fast just time enough to give this impetus, and the bill being opened at that moment and the worm released, it was carried by the force into the throat, and swallowed by the ordinary muscular action of the œsophagus. Toads, chameleons, woodpeckers, and many other creatures, take their prey with an imperceptible motion of the tongue; but in this case it had to traverse the entire length of a long bill.

O. S. ROUND.

METEOROLOGY OF DECEMBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1841	—	21·0	—
1842	57·5	27·5	—
1843	57·0	29·0	1·6
1844	43·0	19·5	0·4
1845	53·0	26·0	4·0
1846	47·5	15·7	1·3
1847	56·0	29·0	3·4
1848	58·1	26·2	2·4
1849	53·0	20·5	3·9
1850	55·0	23·5	1·7
1851	56·3	20·3	1·6
1852	56·5	24·8	2·0
1853	51·0	13·8	0·6
1854	56·6	24·0	2·4
1855	50·8	12·0	0·8
1856	60·2	12·5	1·8
1857	56·8	30·0	0·4
1858	54·0	24·8	1·9

The greatest heat in shade reached 62·0° in 1856, and only 43·0° in 1844, giving a range of 17·2° in greatest heat for December during the past seventeen years.

The greatest cold was as low as 12·0° in 1855, and never below 30·0° in 1857, giving a range of 18·0° in greatest cold for December, during the past eighteen years.

Only 0·4 inch of rain fell in 1844 and 1857, whilst 4 inches fell in 1845, giving a range of 3·6 inches for December, during the past sixteen years. The mean amount of rain for this month is 1·9 inches.

December is a very variable month, depending much on the general direction of the wind for its character; it is, however, usually mild, with the wind blowing between W. and SW.

E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR DECEMBER, 1859.

The sun is in the constellation Sagittarius till the morning of the 22nd, when he passes into Capricornus. In London he rises on the 1st at 7h. 45m., on the 15th at 8h. 2m., and on the 31st at 8h. 9m. He sets on the 1st at 3h. 53m., on the 15th at 3h. 49m., and on the 31st at 3h. 58m. In Dublin he rises 10 minutes later, and sets 10 minutes earlier. In Edinburgh, at the commencement of the month, he rises 26 minutes later, and sets 26 minutes earlier, and at the end rises 27 min. later, and sets 27 min. earlier than in London.

The sun reaches the meridian on the 1st at 11h. 49m. 7s. a.m., on the 15th at 11h. 55m. 13s. a.m., and on the 31st at 12h. 3m. 8s. p.m.

Equation of time on the 1st, 10m. 53s.; on the 15th, 4m. 47s.; and on the 31st, 3m. 8s. Up to Christmas-day clock after sun; after which before sun.

Day breaks on the 1st at 5h. 41m., and on the 29th at 6h. 2m., and twilight ends on the 1st at 5h. 56m., and on the 30th at 6h. 0m. Length of day on the 3rd, 8h. 3m., and on the 23rd 7h. 44m. The length of day has decreased on the 12th 8h. 44m.

Full moon on the 10th at 3h. 13m. a.m.

New moon on the 24th at 5h. 47m. a.m.

The moon is at her greatest distance from the earth on the 29th, and at her least distance on the 13th. She is near Jupiter on the 12th, Saturn on the 14th, Mars on the 19th, and Venus on the 26th.

Mercury is an evening star till the 13th, and then a morning star. He is situated very low, and is, consequently, unfavourable for observation. He is in Sagittarius, passing into Ophinchus at the end of the month. He rises on the 1st at 9h. 38m., and on the 26th at 6h. 15m. He sets on the 1st at 4h. 56m. p.m., and on the 28th at 2h. 48m. p.m.

Venus is unfavourably situated for observation, being low, near the sun, and also at a great distance from the earth. She is an evening star, and is in Ophinchus, passing into Sagittarius in the middle of the month, and into Capricornus at the close. She is nearly circular in form, and rises between 9 and 10 a.m., and sets on the 26th at 5h. 37m.

Mars is unfavourably situated for observation, its disc being less than 5" of arc. He is a morning star, and in Virgo till the end of the month, when he passes into Libra. He rises at about a quarter past three, a.m., and sets on the 26th at 1h. 1m. p.m.

Jupiter is a fine telescopic object, his apparent diameter on the 31st being 44", having increased from 30" since June. He is in Gemini, except for the first few days, when he is in Cancer. He is an evening star, rising on the 1st at 7h. 2m. p.m., and on the 26th at 5h. 20m. p.m., and being on the meridian on the 1st at 3h. 9m. a.m., and on the 26th at 1h. 21m. a.m.

Saturn is an evening star, and a good telescopic object. He is in Leo throughout the month. His motion is direct until the 8th, when he is stationary, and after which retrograde. He rises on the 1st at 9h. 56m. p.m., and on the 26th at 8h. 16m. p.m.

Uranus is favourably situated for observation, being in the constellation Taurus throughout the month. He is on the meridian on the 1st at 11h. 34m. p.m., and on the 26th at 9h. 51m. p.m.

There will be six occultations of stars by the moon on December 8th, viz.:—Electra, 4th magnitude, disappears 3h. 36m. p.m.; and reappears 4h. 25m. p.m. Celœno, 5½th magnitude, disappears 4h. 0m. p.m., and reappears 4h. 9m p.m. Merope, 5th magnitude, disappears 4h. 6m. p.m., and reappears 4h. 49m. p.m. Alcyone, 3rd magnitude, disappears 4h. 32m. p.m., and reappears 5h. 24m. p.m. Pleione, 5½th magnitude, disappears 5h. 18m. p.m., and reappears 5h. 59m. p.m. Atlas, 4th magnitude, disappears 5h. 32m. p.m., and reappears 5h. 38m. p.m.

The following eclipses of Jupiter's satellites are visible:—On the 2nd, at 1h. 2m. 10s. a.m., 3rd moon disappears. On the 2nd, at 4h. 14m. 11s. a.m., 3rd moon reappears. On the 6th, at 11h. 50m. 37s. p.m., 1st moon disappears. On the 14th, at 1h. 53m. 8s. a.m., 1st moon disappears. On the 15th, at 8h. 21m.

30s. p.m., 1st moon disappears. On the 16th, at 1h. 38m. 17s. a.m., the 4th moon disappears. On the 16th, at 5h. 0m. 16s. a.m., 4th moon reappears. On the 17th, at 7h. 15m. 53s. p.m., 2nd moon disappears. On the 22nd, at 10h. 15m. 10s. p.m., 1st moon disappears. On the 24th, at 9h. 52m. 26s. p.m., 2nd moon disappears. On the 30th, at 0h. 8m. 57s. a.m., 1st moon disappears. On the 31st, at 6h. 37m. 26s. p.m., 1st moon disappears. On the 31st, at 12h. 28m. 59s. a.m., 2nd moon disappears.

Meantime of the transit of the first point of Aries:—On the 1st at 7h. 19m. 32s.; on the 15th, 6h. 24m. 29s.; and on the 31st, 5h. 21m. 35s.

E. J. Lowe.

Highfield House Observatory, Nottingham.

THINGS OF THE SEASON—DECEMBER.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

—o—

Birds Arriving.—Pintail, Scaup, Black Velvet and Eider Ducks, Brent and Laughing Geese, Wild Swan, Gray-headed and Orange-headed Gossanders, Black-throated and Red-throated Divers, Grossbeak, Snowflake, White Nun, Long-tailed and Tufted Pochers, occasional flights of Redpoles, Starlings, and Skylarks from the Continent. Woodcocks continue to arrive.

Birds Departing.—Gray Plover.

Wild Plants.—Verrucaria, Endive-leaved Cenomyce, Fringed Bornera, Thelotrema, Spiloma, Targionia, Graphis stricta, Glaucous Riccia, Christmas Rose. Furze and Hepatica bloom in sheltered places. Mistletoe berries ripen.

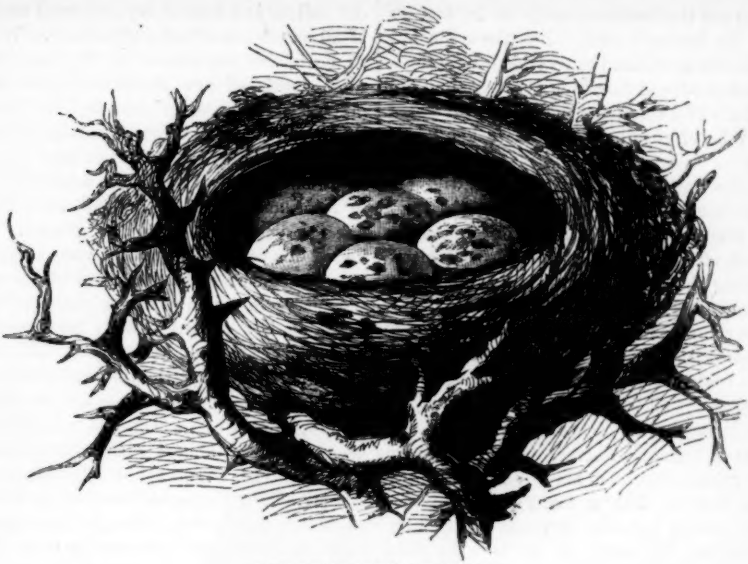
Mr. Noteworthy's Corner.

Duration of Life.—Dr. Guy says that among literary men poets live the shortest lives of any. Taking Tibullus, Persius, Lucilius, Catullus, Virgil, Horace, Ovid, and Martial, as the leading Roman poets, the average duration of life was 48½ years. Against these he places for contrast, Kirke White, Collins, Parnell, Burns, Goldsmith, Thomson, Cowley, Shakspeare, and Pope, and the average is 43 years. Married literary men live longer than the single. Of 188 men of science, the lowest age at death was 22, and the highest 92: the last was a naturalist. Scientific men have an advantage over artists and literary men, but the pursuit of literature is pronounced by Dr. Guy favourable to longevity, but destructive to life at early periods. A comparison of 8449 facts gives as one result that the duration of life of married men is greater than that of the unmarried by as much as 5¾ years.

Portable Furnace.—At a *soirée*, lately held at the London University, Mr. Griffin exhibited a portable furnace of novel construction, adapted for laboratory uses and for amateurs in metal-work. It can be placed on a table or bench, and, by means of a gas-flame, fed by a flexible tube, produces a heat sufficiently intense to melt any of the metals ordinarily used in the arts. The expense of melting 3½ lbs. of copper in ten minutes is three farthings. The caloric is economized, and confined to a small area, by means of earthenware discs; and when the crucible containing the metal is at a white heat, the hand may be placed on any part of the apparatus externally without being burned.

Early Frosts.—During twenty years past, there have been four hard frosts in September, on one occasion as early as the 7th. In fourteen years out of twenty, sharp frosts have occurred between the 20th and 30th of October. The earliest frosts during the past twenty years occurred:—September 7, 1855; thermometer, 28°; duration of frost, one day. September 17, 1840; thermometer, 29°; duration, one day. September 20, 1856; thermometer, 29°; duration, one day. September 27, 1847; thermometer, 28°; duration, one day. During the whole period, the frost of 1859 was most severe, the thermometer was at 17° on the 23rd, and the frost lasted eight days. The frost next in severity to the one of the present year occurred on the 21st of October, 1842, thermometer, 20°. These registrations are from observations made at Chiswick, of which Mr. Thompson has prepared a table, which appeared in the *Gardener's Chronicle* on the 5th of last month.

The October Gales.—Admiral Fitzroy has proved, by statistical data, that most of the painful disasters resulting from the late gales might have been obviated had the plain teachings of science been heeded by the brave mariners whose bones have strewed our shores. The barometer and thermometer distinctly foretold that storms were coming, Science gave warning of what Nature was about to do, and few of the many who perished but had time to prepare against the worst. The low state of the barometer, and the movements of the thermometer, plainly indicated, first, a storm from the north, and next a storm from the south, as eventually happened. Nor was the warning a short one; it gave time for vessels far at sea to prepare to ride it out, and for those near shore to seek a proper refuge, and this the "Royal Charter" might have done, and with all her living freight have come safely into port at last. Mr. Noteworthy rejoices to know that the life-boat and coast-guard stations are to be provided with good barometers, and he hopes no pride of personal daring will stand in the way of a careful study of the indications of the valuable instrument. Mr. Noteworthy learns from his friend, Mr. W. C. Burder, through the columns of the *Times*, that the storm of the 25th and the 26th was, probably, a revolving one, but that the radius was so large, that in the part of its course near Bristol, the tangent and the arc may be considered parallel. With all the dismay and sorrow that come with the warring of the elements, the philosopher will mingle thankfulness that man is not left utterly in the dark, but may, if he chooses, see the cloud no bigger than a man's hand, and shield his head against its bursting.



" His nest is near the garden-door,
But who hath eyes to find it ? "

OUR FRIEND THE ROBIN.

If we held the Pythagorean notion of the transmigration of souls, we might indulge in very pretty speculations as to the antecedents of the spirit of our familiar friend, the Robin Redbreast. His dashing carriage, audacious strut, self-possession, and adventurous courage seem so many indications that his soul is human; for is he not a mixture of the hero, the minstrel, and the coxcomb? In the light of tradition he is not a bird, but a person, and one almost elevated into the ranks of a petty deity. It is hard to say whether the moral story of his life, as we make acquaintance with it by experience, or the mysterious influence of traditionary prestige, is to be regarded as the source of that homage we pay to his name and nature, by which he becomes of right the most sacred of our *lares*. Our hearts leap out to the robin as he leaps in at the garden-door; and if we cannot in the body, at least in the spirit we shake hands with him as the dearest friend of our childhood, and one whom we are prepared to cherish and defend at all hazards. The robin and the sparrow vie with each other in courting the friendship of man. But the robin not only courts, but compels—not only sues, but demands—and so he gains a march on the sparrow, and will be spared by the prosiest blockhead, who would shoot and poison every other bird within his reach. The affection for the robin is shared by all of us alike—it may differ in degree, but not in kind; and even the heartless bird-catcher handles him with more tenderness than any other bird, and *some-*

times has the humane courage to let him go for his beauty's sake. But the robin has character as well as beauty; his bold outline, broad chest, and twinkling eyes give him the attitude of a chieftain; and his breast wears the robe of royalty, by which we know him best.

The unmatched sweetness and wildness of his song—the personal dash of his bearing, his fearless familiarity, his solitariness as he stands all alone on the top of a gate-post, defying the blasts of Boreas and the snow-shrouds and sleety arrows of Death, which have conquered all but him—the brightness of his scarlet breast, and the web of romance that centuries have woven in his honour;—these are sufficient reasons why the robin should enjoy the highest fame among the birds of Britain. Therefore is he our *friend* the robin, whom we never see and never hear but we feel a thrill of homeliness that springs from the very seat of our best affections; for, after all, he is a helpless creature, and our human sympathies warm up with most force and spontaniety for all who tenderly manifest their dependence upon us. If the excellence of love is to be measured by comparisons, the mother loves no child so fervently as the one she has to nurse, and soothe, and nestle to her bosom; and as if he knew that human love must express itself in kindness, he comes without fear to the threshold, and even takes his place at the table to share with us the best we have, and so wins our whole heart by his confidence.

What an uninteresting bird is the robin apart from these poetical features of his history! He takes a wife in direct opposition to the precepts of Malthus, renounces the idea of prudence and provision beforehand for a family, but simply yields to impulse, and "takes no thought for the morrow." The nest is often built while snow lies thick on the ground, most frequently at the bottom of an old hedge, sometimes in a hole in an old wall, or in a boss of ivy, and most rarely of all on the summit of a thick bush. With an instinctive veneration for the past, the robin avoids all new places, and gives the preference to a hedge that has not been clipped for years, in which the stems of the quicks are matted a foot deep in dead leaves and wisps of moist hay; or on a wall that is in ruins, and which the ivy will some day, not far distant, bring to the ground. A hollow in a root, an old pile of mossy faggots, a neglected corner of a woodyard—these are the places in which you may look out for the robin, if you want to study his domestic life. Turner, who wrote on the "Robinet"—he was so called by Drayton and others of the old writers—three centuries ago, set afloat a whole chapter of inaccuracies, which have been copied by almost every writer since, including even Willoughby, Buffon, and Bewick. Turner says, he "nestleth as far as possible from towns and cities, in the thickest copses and orchards;" whereas, in truth, the robin loves the neighbourhood of man all the year round, though his peculiar familiarity is manifested only in autumn and winter; and in every one of the suburbs of London, where there is any touch of rurality, the robin regularly builds, and rears its young. At Stoke Newington, there are as many robins' nests every spring as there are of blackbirds and thrushes; and he is only beaten in this respect by the sparrow, which is a social bird, whereas the robin is a hermit, and an association of hermits would be paradoxical. Turner says, "she covereth her nest with archwork, leaving only one way for entrance, for which purpose she builds with leaves a long porch before the doorway; all which, before going out to feed, she covereth with leaves." This is another mistake, which nearly all the writers on birds have copied; but there is just a grain of truth in it, because the nest is usually in the midst of a collection of drifted rubbish and dead leaves, and is therefore not easy to find; but a

"porch" and a "covering" are inventions of the fancy. The best figure of a robin's nest I have met with is that in the second volume of the Rev. F. O. Morris's "Nests and Eggs of British Birds." It is a moderately neat nest, not particularly finished or artistic, but compact, roomy, and always warm. The mass of the structure consists of moss, dried leaves, and bents; and the lining is usually of linen and wool. I have seen bits of cloth, paper, and Berlin wool worked into nests about London; for, as a genuine rustic, the robin is not over particular, except as to strength and safety. People who collect eggs are a good while obtaining experience in distinguishing those of the robin, for they vary in colour considerably. They are usually freckled with yellow and brown on a white ground, but are sometimes gray, with ferruginous spots, and occasionally of the purest white.

"Art thou the bird whom man loves best,
The pious bird with the scarlet breast,
Our little English Robin?"
WORDSWORTH.

The building of the nest is usually a slow

affair: there is a great deal of fidgeting and caprice; the newly-married pair seem to have no settled views of life, and often lay the foundations of many nests before they finally work in earnest to complete one. A pair that built in my garden last summer, and brought out a strong brood, made choice, I think, of not less than half a dozen places along the length of the privet-hedge, and at last settled within ten yards of the drawing-room windows, whence we could watch my lord and my lady making their excursions, and knew when eggs had been laid by missing my lady altogether. But my lord was so pompous, restless, serious, and busy, that he filled the scene with his own consequential presence, and the square rod of turf which fronted his domain was none too large for him to give it all the life it needed. Rennie tells of a pair building in a greenhouse at Christmas, and bringing out their young, in due course, with perfect safety. The Rev. F. O. Morris gives the following dates at which nests containing eggs were found:—November, 1851, at Gribton, Dumfriesshire; January, 1848, at Moreton, and near York; first week of February, 1844, near York; 20th of February, near Belfast. From the end of April to the beginning of June are the periods when the first broods usually come out—earlier or later, according to the season and the locality. No one unaccustomed to young birds would suppose the little puffy gray things to be robins. They soon, however, acquire the first instalment of their future russet in numerous rust-coloured spots, and these gradually disappear; towards August the "scarlet" of the breast begins to show itself distinctly. Then old and young alike acquire their proper winter plumage, and towards the middle of September robins appear to be suddenly plentiful, as if they were birds of passage and had just arrived, whereas with little song and very sober coats, the old birds have been close to us all summer, and their numbers are now increased by the young of the year.

Long before the young birds have acquired their russet garb, they demonstrate themselves to be robins by their pugnacity. Before they have full strength to leave the nest and shift for themselves, they fight amongst each other, and no sooner is it plainly evident that if kicked out they need not perish, than they *are* kicked out. The father knows them no longer, except as enemies against whom he rejoices to show the strength of his beak and claws. From this time till the season of nidification again returns, robins prove their royalty by their love of combat. Old birds and young birds, cock birds and hen birds, all fight, and prefer to fight each other rather than any meaner foes. At pairing time the pugnacious passion is at its height among the males; every attitude, every movement, every song, have all one meaning—*fight*. When the robin's song is at its best, at the end of September, and again just after the turn of the year, take note of the way in which he performs his minstrelsy. He comes with a flirt over the fence and alights on the ground, his beautiful breast burning with martial hues, and his heart beating with martial passions. He does not hop like a common bird, but shuffles, three hops at a time, with a small flutter at the end, then shuffles again, and presently flirts on to the rail, post, or branch which gives him the best view of your face, and there, eying you with dignified confidence, he trills out his short, plaintive, and mellifluous song. Now listen! That same song, note for note, is immediately repeated from a neighbouring tree or fence, and see! he has been listening for it with all his feathers ruffled, knowing that if there be one of his race within hearing, his defiant piping will be answered in the same strain of wildness and of war. Yes, it means war, sweet as it is; and rarely does the robin sing except as a challenge which the next within hearing is always bold enough to answer. You may hear fifty robins in the course of a short

walk, and every one will be found to sing, pause for reply, and sing again, and every separate song is an invitation to mortal combat. When they fight, as they do frequently, it is without quarter on both sides —one of them is almost sure to perish. Many a robin have I found and buried with martial honours, pronouncing him a "little fool," when his mite of a body, all ruffled and blood-stained, has been in my hand; but the battles take place usually at day-break, and none but early risers have a chance of witnessing this trait of the robin's character.

Rennie *once* saw an instance at Compton Bassett, in Wiltshire, "in which a redbreast made a daily visit in summer *within* a cottage-door." Wonderful sight to see! how many hundreds of such "instances" have country people, who are not naturalists, seen? Why, there is hardly a countryman in the three kingdoms but, at some time or other, has seen a robin go within the cottage-door; and any man with a goodnatured face may scrape acquaintance with the robin without ceremony of introduction, for his motto is *veni, vidi, vici*—it is not for you to seek him, he makes the direct appeal by placing himself in your power, and, unless you are a downright brute, you are beaten by his confidence. He is the friend of man, and is determined that man shall be his friend. When caged, and so despoiled of that joyous liberty he loves so much, to sing and slaughter at his own free-will, he still is the most impudent of all birds. I never keep but one caged robin, and that is only during the winter months. I let him free in March, as they are easily caught, and easily kept, but are apt to die in summer. This is the way to indulge your own desire without doing grievous wrong—nay, robins often perish of cold and want in winter, for they are not so hardy as they look, and by keeping a robin over winter only, one may console one's self by the belief that the bird has been rescued from possible misery. My present "Bobby" came home three miles screwed up in a paper bag inside my hat. In three days he was at home in his cage, in a week he was as tame as an old canary. The secret is to give insect food in plenty; quietly drop in the cage one meal-worm, or one spider, or a small earth-worm. Presently you hear a tapping, and the prey is swallowed. Give another, and another, till Bobby has made away with half a dozen. Leave him alone for an hour, then fill his food-vessel with a paste made thus: grated carrot as much as will fill a table-spoon, a quarter of a French roll steeped for a minute in boiling water, squeezed dry, and then slightly wetted with boiling milk, a table-spoonful of hemp-seed scalded with boiling water and drained quite dry; mix all together, and let him have a little at a time; it will keep two days in a cool place, and in cold weather need only be made twice a week—of course if it gets sour it should be thrown away. With this and daily supplies of animal food, whether insects or minced beef, robins always do well, and there is no occasion for German paste, or any other mysteries. When once he takes fairly to the food, place a meal-worm on the open palm of your hand and let his door be opened. If he does not sweep over your hand and carry away the meal-worm on his way to alight on a cornice or a curtain-pole, *then* you are not clever in managing birds, and must hope for better luck in future.

I never would keep a robin except as a member of the family, with liberty to go in and out of his cage as he pleased, and with a special welcome to hop about the table at meal times, and help himself from every dish. To make sure of success, you must get a strong bird that has been caged when "gray." To catch one at this season is to sacrifice it, for it will sigh itself away and break its heart at the loss of freedom. With a good gray the case is different. He loves his cage as much as you love your home, and if you open the cage-door when all is quiet, he will at once explore the room, and be as thoroughly

at home as any of your children. Throw a meal-worm on the floor, his quick eye will detect it, and he will, by his look, ask you for another. Gratify his whim, and presently present one in the palm of your open hand, and, by a graceful sweep on the wing, it will be taken; and from that moment you and he are the best of friends.

Now you may enjoy a hearty laugh at his expense. Set on the table an earthen pan, filled to within an inch of the rim with water, on which float a good-sized bung, or a flat piece of wood measuring say three inches each way; your friend will alight on the edge instanter, then take to the raft, and there splash and dip till drenched to the skin. His efforts to balance himself as the frail support tilts over with him, will prove the best fun you have had this season; and it will be better fun still when the "drowned rat" betakes himself to the front of the fire, to shake himself dry in the enjoyment of the warmth. Don't be in haste to pronounce this cruel, for the robin is as fond of water as a Newfoundland dog.

The personal bravery of this bonny bird is all in keeping with his place in history and tradition. Is there a national folk-lore of any kind that lacks a legend of the robin? Didn't we all make acquaintance with "Cock Robin" in nursery rhymes that will never die out of our memories? Haven't we all wept, and are ready to weep again, at the dear old story of the "Babes in the Wood," whose little lifeless forms were buried decently with the perfumed strewings of the autumn, in the lonely land of blackberries? Cannot we trace to that legend very much of the sanctity with which the robin is invested as the bird of privilege, to be protected and cherished in the enjoyment of his native wildness? All the robin legends have the same tendency to endear him to us. In Brittany there is a legend that when the Saviour was bearing his cross, a redbreast plucked a thorn from his crown, which, piercing its breast, dyed it with the stain that has ever since sufficed to link it with our sympathies.

In poetry he bears a variety of designations. Shakspere makes a comparison of his "love song," and Ophelia, in her madness, sings of him as "all her joy." Carrington calls him "the bird of autumn," and "sweet household bird." Dr. Jenner describes him as "the sweetest of the feathered throng," and thinks of him as the "helpless bird." Wordsworth as the "pious bird," and Grahame, in plain English, calls him "the friend of man." He is too thoroughly English to possess classical distinctions. The Greek poets wanton with swans, and nightingales, and swallows, that "bring the message of the gods;" and the Roman poets gave their hearts to bees and roses, all-forgetful of the homely redbreast. Even Keats was too much flushed with the wine of an old vintage, too much dazed by god Bacchus, and lulled by the fragrance from pagan altars, to befriend the robin with a word of praise. Is it not the robin that Tennyson alludes to as the

> "Wild bird whose warbled liquid sweet
> Rings Eden through the budded quicks?"

Strange omission if the wondrous dirge, "In Memoriam," has no place in it for the very type of tenderness for the "sacred dust." He must be there, though I have failed to find him. One more of these citations must suffice to bring the story of the robin to an end. Grahame has a passage descriptive of the robin's visit to a smithy, which Sydney Yendys *may* have read ere he penned that famous line, "blows the rough iron of his heart red-hot"—

> "Fearless of the clang and furnace glare,
> Looks round, arresting the uplifted arm,
> While on the anvil rests the glowing bar."

Here, then, we bid him farewell, and when his loud canticle—best of Christmas carols—breaks the silence of the wintry air, we will delight to hail him as OUR FRIEND THE ROBIN.

SHIRLEY HIBBERD.

THE ANECDOTE HISTORY OF PHOTOGRAPHY.

COLLECTION I.

It would be superfluous to enter into any lengthened or learned dissertation on the origin of the term Photography, suffice it to say that it is derived from the Greek words *phos* (*photos*) and *grapho*, which in English signify to draw or paint by the agency of light. The art has also been called Heliography, a term compounded of two Greek words, meaning to paint or draw by the agency of sunlight; and indeed this latter appellation better illustrates our topic when we speak of the science of the sunbeam—the sunbeam or pencil of light that portrays, on any properly prepared surface, and through the medium of the delineating lens, either portraits, pictures, or landscapes.

Photography, or the science of the sunbeam, has thus become essentially one of the most beautiful and graphic arts of the day, and has proved itself an invaluable auxiliary to the progress and promotion of almost every art and science, while its general diffusion throughout England, the Continent, and the world, is no small proof of its universality and value. We have now a central society in London—the Photographic Society and Exhibition—numbering between 400 and 500 of the most eminent practical photographers; another in France, and others in the principal continental cities. There are numerous artists of eminence in London who practice photography as a profession, while the total number of those who devote themselves to it in the metropolis and provinces may be estimated by hundreds. Then there are amateurs without number, a multitude of professed photographic material dealers and practical apparatus makers, while the money expended in the art amounts to many thousands a year. Most of our large English cities have their photographic societies and exhibitions, and one has been recently established in India. In addition to this, it has given great impetus in a new direction to the glass and chemical trades, to the frame manufacturer, to the miniature painter, the optician, the paper-maker, and the picture-seller. No fewer than thirty different processes have been invented for taking photographs on paper, though these, since the introduction of the collodion and albumen processes on glass, have been comparatively abandoned.

Unlike steam, telegraphs, and railways, the origin of photography is *not* involved in obscurity. It is, in fact, one of the brilliant discoveries of our own day and generation, and dates from the beginning of the present century. Its foreshadowing is by some very imaginative people traced to those lines in Milton, where he is supposed to hint at some magic process of after-time, in which,

> "With one touch virtuous
> The arch-chemic sun, so far from us remote,
> Produces."

Others, speculating on its origin, allege that photography, in some rude form, was known to the Indian jugglers. Suppositions of an equally interesting and ingenious character assert that our great mother Nature was the authoress of all photography; that she it was who first placed it in the cradle of discovery, where it was nursed by light, and nourished on sunbeams. These and other interesting photographic facts will be illustrated more in detail by the anecdotes that follow.

There is a story that the first principles of a peculiar photographic process were discovered fifteen years ago by M. Bayard, on the amber and purple surface of a peach. Proud of his peaches, M. Bayard, it is said,

was accustomed to mark them with his initials. To effect this he was in the habit of gumming on to the surface his initials cut in small paper characters, and which, under the action of the autumn sun, left their impression on the ripening fruit.

PHOTOGRAPHIC EFFECTS OF LIGHTNING.—The first authentic mention of this singular natural phenomenon was made by Franklin in 1796, who states that a man who was standing opposite a tree that had just been struck by a thunderbolt, had on his breast an exact representation of the tree. On August 26, 1823, a little girl was standing at a window, before which was a young maple-tree. After a brilliant flash of lightning, a complete image of the tree was found imprinted on her body. M. Raspail records that in 1855 a boy climbed a tree to rob a bird's-nest. The tree was struck, and the boy thrown to the ground, and on his breast the image of the tree, with the bird and nest on one of its branches, appeared very plainly. Signor Orioli brought before the scientific congress at Naples the following cases of impressions made by lightning:—In September, 1825, the lightning struck the foremast of the brigantine, St. Buon Servo, when a sailor under the mast-head was struck dead, and an impression of a horse-shoe, like that fixed at the mast-head, was found upon his back. On another occasion a sailor standing in a similar position had on his breast the impression 44, with a dot between the two figures, corresponding with the figure 44 at the mast-head. On October 9, 1856, a young man was found struck by lightning. He had on a girdle with some gold coins in it, and they were imprinted on his skin in the same manner as they were placed in the girdle. In 1836 an Italian lady of Lugano was at a window in a thunder-storm, and a flower that happened to be in the path of the electric current was perfectly reproduced on her leg, and there remained permanently. On July 24, 1852, a poplar-tree in a coffee plantation was struck by lightning, and on one of the large dry leaves was found an exact representation of some pine-trees that lay at a distance of 367 yards.

The above cases, were they not clearly explainable on scientific grounds, would almost appear to be incredible; but they are not one-half so difficult of belief as that alleged marvellous discovery by Dr. Conyers, who, it is said, on anatomizing a gentleman who died for love, found an impression of the lady's face upon his heart.

THEORETICAL EXPLANATION OF LIGHTNING IMPRESSIONS.—M. Poey, director of the Observatory at Havana, is of opinion that these impressions are produced in the same manner as the curious electric images obtained by Karslen, Grove, and Fox Talbot, either by statical or dynamic electricity, of different degrees of intensity. The fact that impressions are made through garments, is accounted for when we remember that their rough texture does not prevent the lightning passing through them with the impression it has received.

OIL-PAINTED PHOTOGRAPHS.—Photographs have been produced by Mr. Parris, the artist, painted in oil, so as to have all the effect of the most finished miniatures. The oil process removes those over-strong markings which photography, at its best, produces in portraits.

CURIOUS HALO LIGHT ROUND PORTRAITS AND PICTURES.—This curious appearance is found to arise from the reflected light in and from the lens. The positive picture is found to have a sort of halo of light about the centre of the picture, and the same appears in the negative, but reversed, *i.e.*, black.

PHOTOGRAPHIC EFFECTS OF ONE LEAF ON ANOTHER.—Mr. Piesse has called attention to the delicate shading or finishing of leaves produced by the photographic touch of the sun, in the case of geranium and other leaves, where one leaf produced a shade

upon the other, the under leaf presenting a beautiful photograph of the upper one, its serrated edge and form being perfectly defined. Wherever the shade was cast, that part of the leaf was of a deep green, while the unshaded parts were of a pale sea-tint.

First Principles of Photography Known to the Alchemists.—The action exercised by light upon fused chloride of silver, horn-silver, is alleged by Dr. Halleur, of Berlin, to have been known to the alchemists as early as the 16th century, who noted that light imparted a black tint to the originally white salt of silver. The chloride of silver suffers under the influence of the prismatic rays.

The Phenomena Noticed by Subsequent Experimenters.—Petit published his observations upon the influence of light on the crystallization of various salts in 1722, and Chaplot and Diezé in 1788 and 1789; and Scheele, in 1777, published his observations on the nigrescence of chloride of silver under the influence of light, and on the alterations.

Silhouette Figures Taken by the Action of Solar Light.—One of the earlier chemists, M. Charles, is recorded, about this period, to have exhibited, in his lectures at the Louvre, a paper capable of taking silhouette figures by the action of solar light, but no account has come down of his process.

Wedgewood, the First Photographer.—The honour of being the first practical photographer is generally conferred upon Wedgewood, who, in 1803, contributed a paper to the Journal of the Royal Institution, accompanied by observations from Sir Humphry Davy, entitled "An Account of a Method of Copying Paintings upon Glass, and of Making Profiles by the Agency of Light upon Nitrate of Silver." White paper, or white leather, saturated with a solution of nitrate of silver, served as the impressionable surface. Wedgewood's description of his discovery is too remarkable not to be recorded. He says:—"The alteration of the colours commences the more speedily in proportion to the degree of the intensity of the light. In bright sunshine, from two to three minutes suffice to produce the full effect; whereas, in the shade, several hours are required to arrive at the same effect. Through differently coloured glasses the light acts with different degrees of intensity. When the shadow of a figure is thrown upon the prepared surface, the parts covered by the shadow remain white, whilst the other parts speedily turn black. To copy paintings on glass, the negative images should be taken on leather, because the action is more rapid with this material than if paper were used. When the colour is once fixed on leather or paper, it proves fast to a degree; water, and even soap and water, failing to remove it. Besides the method of copying just given, there are several others. It will be useful to make copies of all such objects as are partly transparent and partly opaque. The woody fibre of the leaves of plants and the wings of insects may be very accurately copied in this manner. All that is needed to this end is, to transmit the direct light through the object to be portrayed, and to receive the shadow on prepared paper or prepared leather."

Experiments by Sir Humphry Davy.—Sir H. Davy, in commenting on Wedgewood's discovery, says:—"It has been observed that the image of the camera obscura is too feeble to make an impression upon the nitrate of silver within a reasonable space of time. To copy these images was Wedgewood's chief object. I followed up his experiments, and found that the images of small objects produced by the solar microscope may be copied without difficulty on prepared paper. A comparison of the effects produced by the action of light upon chloride of silver, with those produced on nitrate of silver, fully and clearly showed that the chloride is the more sensitive compound of the two. All that is required now to render these experiments as

useful as they are interesting, is to find a way of preventing the subsequent colouring of the white parts upon exposure to daylight."

Causes of Wedgewood's and Davy's Failure.—After these results by Wedgewood and Davy, no experiments were made for many years; their failure owing solely to the fact that the agents now used with such success to fix the image by acting on the nitrate of silver, were then unknown. Hyposulphate of soda, discovered by Sir John Herschel in 1819, and iodine, discovered in 1812, were then unknown, and without the discovery of these or similar agents, photography would probably never have reached its present point of perfection.

The Daguerreotype.—So named after Daguerre, who commenced his experiments in 1824, and having become acquainted with Niepce in 1826, they pursued their experiments together. In 1829, they employed "iodine," from sea-weed, to blacken the plate which held the heliographic impression, which they applied with the greatest success to that purpose. It took about twenty minutes to obtain an impression. The picture is taken on a copper-plate with a silver surface, now under the operation of M. Claudet, who adopts the Daguerreotype, and whose system is said to be followed by all the so-called American inventions.

The Discoveries of Niepce and Daguerre.—In 1814, Niepce, after a series of experiments, succeeded in fixing the images of the camera obscura, having discovered the peculiar property of the solar rays to alter the solubility of resinous substances. He spread a thin layer of asphalte on a glass or metal plate in the camera obscura, and, after waiting from five to six hours, he found on the plate a latent image, which became visible on treating the surface of the plate with a solvent. In 1827, he made experiments at Kew, and some of the pictures are said to be preserved there.

Invention of the Collodion Process.—A friend of the late Mr. Scott Archer, the inventor of the collodion process, says that on September 19, 1850, Mr. Archer communicated to him his discovery, and they made the first collodion picture together. He had previously imparted the secret to one or two friends, who assumed to themselves more or less of the credit of the discovery. The collodion process undoubtedly ranks above all others, both as a sensitive medium, and for the exactness and beauty of the images it develops. It is so instantaneous in its action that clouds, waves, ships, and figures in motion, may be taken by a single lens.

Charles Maybury Archer.

SPORTIVE EXERCISES UPON MUSICAL NOTATION.

IN TWO PARTS.—PART I.

The present paper is intended to serve the laudable purpose of impressing upon the mind the names, relative value, and use of the ordinary musical signs. It does not pretend to contain all, or even the half, of what might be done in the same way; but may prove useful, as well as amusing, upon the principle of *verbum sapienti*. Every one is presumed to have learned a little of music; not every one can read a page of musical notes. The Sportive Exercises, by presenting, in the form of problems, the simplest rules and terms of musical notation, may afford, in the hands of a teacher, armed with chalk and black board, an hour's profitable recreation to a class, and at the same time give the soli-

tary musical tyro a little help towards the removal of a very common difficulty.

SECTION I.—DEFINITIONS.

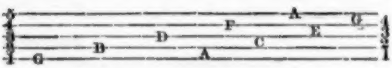
All musical sounds are expressed by certain characters called notes, which are named from the first seven letters of the alphabet—A, B, C, D, E, F, G.

These notes are written upon a Staff,  which is a figure formed of five lines and four spaces. The lowest line is called the first.

The Staff used for the notes of the right hand, in playing upon the pianoforte, is called the Treble Staff; that used for the left hand is called the Bass Staff.

The names of the lines and spaces of the Treble Staff are as follow :—

The names of the lines and spaces of the Bass Staff are as follow :—



Problems upon Section I.

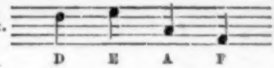
Write upon the Treble Staff, in notes of this character ♩, the words—1. Ace; 2. Aged; 3. Cage; 4. Deaf; 5. Ceded; 6. Bee; 7. Bede; 8. Baggage; 9. Cabbage; 10. Dace; 11. Faded; 12. Egg.

Solutions.

1. 

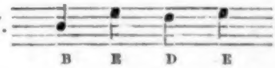
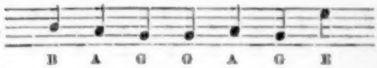
2. 

3. 

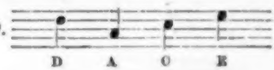
4. 

5. 

6. 

7. 

8. 

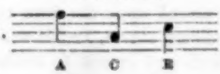
9. 

10. 

11. 

12. 

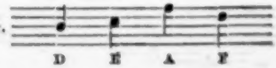
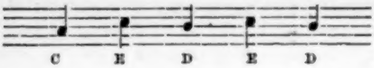
Write the foregoing twelve words upon the Bass Staff.

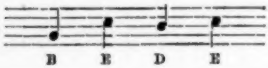
Solutions.

1. 

2. 

3. 

4. 

5. 

6. 

7. 

8. 

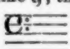
9. 

10. 

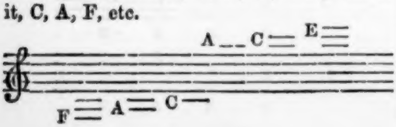
11. 

12. 

SECTION II.—CLEFS AND LEGER LINES.

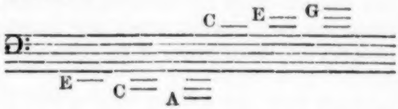
The Treble and Bass Staves are distinguished from each other by means of certain marks called Clefs. These are for the former a mark like 𝄞, thus:  For the latter a C, thus:  The Clefs determine the names and spaces of the notes placed upon the lines and spaces. But the ordinary staves, Treble and Bass, not being of sufficient extent to contain all the notes that can be sung or played, certain additional lines above and below the Staff are added. These are called Leger Lines.

The Leger Lines of the Treble Staff are—above the Staff, A, C, E, etc.; below it, C, A, F, etc.



The Spaces above the Staff are, G, B, D, etc.; below, D, B, G, etc.

The Leger Lines of the Bass Staff are—above the Staff, C, E, G, etc.; below it, E, C, A, etc.



The Spaces above the Staff are, B, D, F, etc.; below it, F, D, B, etc.

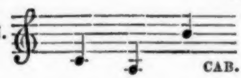
Problems upon Section II.

Write upon the Treble Staff, using Leger Lines and Spaces above or below when necessary, the following words in this character, 𝅘𝅥. First *upon the lines only*:—1. Baggage; 2. Cab; 3. Fee; 4. Caged; 5. Fed; 6. Face.

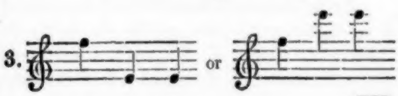
Solutions.

1. 

BAGGAGE.

2. 

CAB.

3. 

FEE.

4. 

CAGED.

5. 

FED.

6. 

FACE.

Next, *using the Spaces only*:—

SOLUTIONS.

1. 

BAGGAGE.

2. 

CAB.

3. 

FEE.

4. 

CAGED.

5. 

FED.

6. 

FACE.

Write the same words upon the Bass Staff, with its LEGER LINES above or below, *at first using only the lines* as before:—

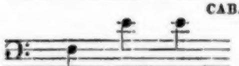
SOLUTIONS.

1. 

BAGGAGE.

2. 

CAB.

3. 

FEE.

4. 

CAGED.

5. 

FED.

6. 

FACE.

Write the same, using only the Spaces:—

SOLUTIONS.

1. 

BAGGAGE.

2. 

CAB.

3. 

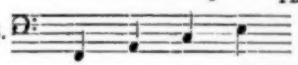
FEE.

4. 

CAGED.

5. 

FED.

6. 

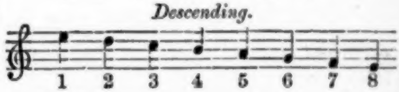
FACE.

SECTION III.—INTERVALS.

The distance between one note and another upon the Staff, or the difference between two sounds in point of GRAVITY or ACUTENESS, *i.e.*, in DEPTH OR SHRILLNESS, is called an INTERVAL. The least of our Intervals is called a semi-tone, or half-tone. The greatest may be several octaves.

EXAMPLES OF INTERVALS.

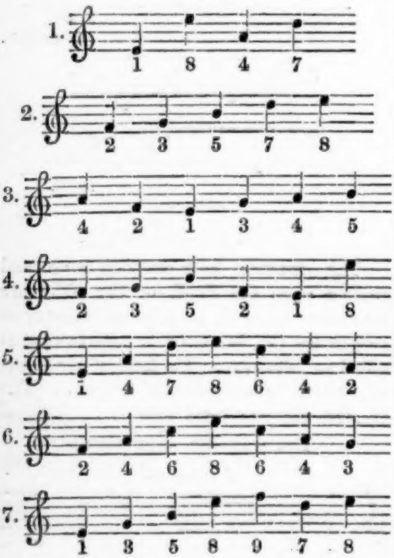
Ascending.

Descending.

Starting from any one note of the scale, the note next contiguous to it is called a SECOND; the next is a THIRD; the next, a FOURTH; the next, a FIFTH; the next, a SIXTH; the next, a SEVENTH; the next is an EIGHTH, or OCTAVE; the next is a NINTH; and so on.

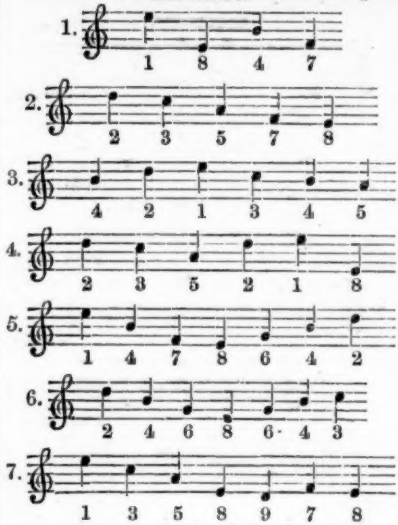
Taking the above Ascending Treble Staff for a basis; calling a second *two*, a third *three*, and treating the other INTERVALS in a similar manner; and letting the E upon the first line stand for the figure *one*, enforce your acquaintance with these Intervals by means of the following—

PROBLEMS UPON SECTION III.

Write the numbers—1. 1847;* 2. 23578; 3. 421345; 4. 235218; 5. 1478642; 6. 2468643; 7. 1358978.

SOLUTIONS.

The foregoing are exercises upon the *Ascending* Staff. It is equally necessary to practice downwards. The same numbers may next be used in connection with the *Descending* Staff above printed; the E in the fourth space standing for the figure *one*, and the E upon the first line for *eight*.

* *i.e.*, Write the *first* note, then the *eighth*, then the *fourth* (from E, 1), then the *seventh*.

SOLUTIONS.

These are given as a means of habituating the young student to measure distances or INTERVALS in ascending and descending; to be able to do which *readily* will be of incalculable advantage to him.

W. NEWMAN.

REFLECTION FROM POLISHED SURFACES.

EVERY one sees that when light, homogeneous or mingled, falls upon any rough surface, it is differently acted upon than would be the case were that surface either artificially or naturally polished. In the former case, certain rays are supposed to be absorbed, and others, producing its colour, reflected. As regards polished surfaces, we find that the light falling upon them, whether homogeneous or mixed, is reflected in a different manner. If white light falls upon a surface of polished brass, it is found that the objects in front of

it are reflected, which reflection varies in intensity with the colour of the reflecting surface. The reflection from white surfaces is the brightest, because here the greatest number of rays is reflected, and its intensity diminishes as the proportion of those absorbed increases.

The reflection of non-luminous bodies, which characterizes polished surfaces, may, perhaps, be explained, when we consider that the asperities of such are far more reduced than those of rough objects. When light falls upon rough or unpolished surfaces, as a piece of slate, it is easy to conceive that the rays, before quitting them, are many times reflected, which, of course, renders them feeble, and thus unable to return the impressions of objects in front. Consequently, if this explanation is accepted as true, the difference of reflection from polished and rough surfaces is merely one of degree, although apparently of kind. The reflection of light from unpolished surfaces only suffices to produce blank colour, showing nothing beyond. I consider this hypothesis strengthened by the fact, that unpolished surfaces will, although not very distinctly, reflect luminous bodies; a wall will reflect the image of a candle if placed pretty close to it, from which it appears probable that the strength of the rays overcomes the many reflections, and thus, for the time, causes a rough surface to act as a polished one.

J. A. Davies.

A CATALOGUE OF ALL THE COMETS WHOSE ORBITS HAVE HITHERTO BEEN COMPUTED.

A new comet having been discovered, the first thing an astronomer does, is to obtain three observations of it, whereby he may compute the elements of the orbit. He then examines a catalogue of comets, to see if he can identify the newly-found stranger with any that have been before observed. The value of a complete catalogue is therefore obvious, and as nothing of the kind has, as far as the writer is aware, been published for some years, he has been led to compile a new one.

In the preparation of the following, care has been taken that only the most reliable orbits that were to be obtained should be inserted, the general rule being to prefer the one which was derived from the longest arc, other things being satisfactory. Among the authorities consulted may be mentioned Pingrè, Hussey, Olbers, Cooper, Hind, Arago, and others.

From the Journals of the Royal Astronomical Society of London, the Academy of Sciences of Paris, the Astronomische Nachrichten, etc., much valuable information has also been obtained.

PP denotes the time of perihelion passage expressed in Greenwich mean time, N.S., since 1582.

π denotes the longitude of the perihelion.

Ω denotes the longitude of the ascending node.

ι denotes the inclination of the orbit to the plane of the ecliptic.

q denotes, the perihelion distance expressed in semi-diameter of the earth's orbit.

ϵ denotes the eccentricity (of an elliptic orbit).

μ denotes the direction of motion, + direct, − retrograde.

The periods assigned in the column of "duration of visibility" are subject to much uncertainty in the case of the ancient comets.

No.	Year.	PP.	π.		☊.		ι.		q.	ε.	μ.	Calculator.	Date of Discovery.	Discoverer.	Duration of Visibility.
		d. h.	°		°		°								
1	370 B.C.	Winter	150—210		270—330		above 30		very sm.	...	—	Pingrè	...	Greek obs.	(?).[1]
2	136	April 29	230		220		20		1·01	...	—	Peirce	...	Chinese obs.	5 weeks.
3	68	July	300—330		150—180		70		0·80	...	+	Peirce	68, July 23	Ditto	5 weeks.[2]
4	11	Oct. 8, 10	280		28		10 +		0·58	...	—	Hind	11, Aug. 26	Ditto	9 weeks.[3]
			°	′	°	′	°	′							
(4)	66 A. D.	Jan. 14, 4	325	0	32	40	40	30	0·445	...	—	Hind	66, Jan. 31	Ditto	7 weeks.[4]
(4)	141	March 29, 2	251	55	12	50	17	0	0·720	...	—	Hind	141, Mar. 27	Ditto	4 weeks.[5]
5	240	Nov. 9, 23	271	0	189	0	44	0	0·372	...	+	Burckhardt	240, Nov. 10	Ditto	6 weeks.[6]
(4)	451	July 3, 12	......		......		......		......	...	...	Laugier	451, May 17	Ditto	13 weeks.[7]
6	539	Oct. 20, 14	313	30	58 or 238		10	0	0·341	...	+	Burckhardt	539, Nov. 17	Ditto	9 weeks.[8]
7	565	July 11, 18	84	0	158	45	60	30	0·775	...	—	Burckhardt	565, Aug. 4	Ditto	15 weeks.[9]
8	568	August 29, 7	318	35	294	15	4	8	0·907	...	+	Laugier	568, Sept. 3	Ditto	10 weeks.[10]
9	574	April 7, 6	143	39	128	17	46	31	0·963	...	+	Hind	574, May 2	Ditto	13 weeks (?).[11]
(4)	760	June 11	......		......		......		......	...	...	Laugier	760, May 16	Ditto	8 weeks.[12]
10	770	June 6, 14	357	7	90	59	61	49	0·642	...	—	Laugier	770, May 26	Ditto	10 weeks.[13]
11	837 i.	Feb. 28, 23	289	3	206	33	10 or 12		0·580	...	—	Pingrè	837, Mar. 22	Ditto	5 weeks.[14]
12	961	Dec. 30, 3	268	3	380	35	79	33	0·552	...	—	Hind	962, Jan. 28	Ditto	5 weeks.
(4)	989 iii.	Sept. 11, 23	264	0	84	0	17	0	0·568	...	—	Burckhardt	989, Aug. 5	Ditto	5 weeks.[15]
(4)	1066	April 1, 0	264	55	25	50	17	0	0·720	...	—	Hind	1066, April 2	Ditto	6 weeks or +.[16]
13	1092	Feb. 15, 0	156	20	125	40	28	55	0·928	...	+	Hind	1092, Jan. 8	Ditto	17 weeks.[17]
14	1097	Sept. 21, 21	332	30	207	30	73	30	0·738	...	+	Burckhardt	1097, Sept. 30	Ditto	4 weeks.[18]
15	1231	Jan. 30, 7	134	48	13	30	6	5	0·948	...	+	Pingrè	1231, Feb. 6	Ditto	4 weeks.
16	1264	July 15, 23	272	30	175	30	30	25	0·430	...	+	Pingrè	1264, July 14	China & Europe	3 months.[19]
17	1299	March 31, 7	3	20	107	8	68	57	0·318	...	—	Pingrè	1299, Jan. 24	Chinese	11 weeks.[20]
18	1301 i.	September	180		60		80		0·333	...	+	Burckhardt	1301,	(?)	(?).[21]
(4)	1301 ii.	Oct. 23, 23	312	0	138	0	13	0	0·640	...	—	Laugier	1301, Sept. 16	China & Europe	6 weeks.[22]
19	1337 i.	Jan. 15, 1	2	20	93	1	40	28	0·828	...	—	Laugier	1337, May	Ditto	3 or 4 months.[23]
20	1351	Nov. 25, 23	69	0	......		......		1·0	...	+	Burckhardt	1351, Nov. 24	Chinese	1 week.[24]
21	1362 i.	March 11, 4	219	0	249	0	21	0	0·456	...	—	Burckhardt	1362, Mar. 5	Ditto	5 weeks.[25]
22	1366	October 13	66	0	212	0	6	0	0·958	...	...	Peirce	1366, Aug. 26	Ditto	Several days.[26]
(4)	1378	Nov. 8, 18	299	31	47	17	17	56	0·583	...	—	Laugier	1378, Sept. 26	Ditto	6 weeks.[27]
23	1385	Oct. 16, 6	101	47	268	31	52	15	0·774	...	—	Hind	1385, Oct. 23	Ditto	(?).[28]
24	1433	Nov. 5, 4	262	1	110	9	77	14	0·329	...	—	Hind	1433, Oct. 12	Ditto	2 months (?).
(4)	1456	June 8, 22	301	0	48	30	17	56	0·586	...	—	Pingrè	1456, May 29	Europe & China	1 month.[29]
25	1457	Sept. 3, 16	92	48	256	6	20	20	2·103	...	+	Hind	1457, June	European obs.	3 months.[30]
26	1468 ii.	Oct. 7, 9	356	3	61	15	44	19	0·853	...	—	Laugier	1468, Sept.	Ditto	2 or 3 months.[31]
27	1472 i.	Feb. 28, 5	48	3	207	32	1	55	0·539	...	—	Laugier	1471, Dec.	Regiomontanus	3 months.[32]
28	1490	Dec. 24, 11	58	40	288	45	51	37	0·738	...	+	Hind	1491, Jan.	Chinese obs.	(?).[33]
29	1506	Sept. 3, 15	250	37	132	50	45	1	0·386	...	—	Laugier	1506, July 31	Ditto	2 weeks.[34]
(4)	1531	Aug. 24, 21	301	39	49	25	17	56	0·5670	...	—	Halley	1531, July 13	P. Apian	5 weeks.[35]
30	1532	Oct. 19, 14	135	44	119	8	42	27	0·6125	...	+	Méchain	1532, Sept. 22	P. Apian	10 weeks.[36]
30	1532	Oct. 19, 22	111	7	80	27	32	36	0·5091	...	+	Halley			

[1] Is said to have separated into two parts.

[2] It had a short, but brilliant tail.

[3] An apparition of *Halley's comet* (?), mentioned by Dion. Cassius as having been suspended over Rome, previous to the death of Agrippa.

[4] An apparition of *Halley's comet* (?). It had a tail 8° long.

[5] An apparition of *Halley's comet.*

[6] Elements somewhat doubtful. It had a tail 30° long.

[7] Undoubtedly an apparition of *Halley's comet.*

[8] It had a tail 10 feet long.

[9] A mean orbit. It had a tail 10° long.

[10] Elements very reliable. On September 8th it had a tail 40° long.

[11] Elements uncertain.

[12] An apparition of *Halley's comet.*

[13] It had a tail about 30° long.

[14] Tolerably trustworthy. The maximum length of the tail was 80°, but it dwindled down to 3° in a fortnight.

[15] Probably an apparition of *Halley's comet.* Mentioned by several Saxon writers.

[16] Possibly an apparition of *Halley's comet.* This is the famous object which created such universal dread throughout Europe in 1066. In England it was looked upon as a presage of the success of the Norman invasion.

[17] Elements satisfactory.

[18] A tail 50° long. Was seen in China, and much bifurcated.

[19] One of the grandest comets on record. Its tail is said to have been 100° long.

[20] Elements very doubtful.

[21] Very uncertain.

[22] Probably an apparition of *Halley's comet.*

[23] A fine comet. The elements assigned by Halley, Pingrè, and Hind differ somewhat from those here given.

[24] Very uncertain. No latitudes given.

[25] Uncertain. The tail was 20 *feet long,* and the head was *the size of a wine-glass!*

[26] Very uncertain.

[27] An apparition of *Halley's comet.*

[28] Tolerably certain. The tail was 10° long.

[29] An apparition of *Halley's comet.* It had a splendid tail, 60° long.

[30] Only approximate.

[31] Uncertain.

[32] A celebrated comet. When at its least distance from the sun (3,300,000 miles) on January 21, it was quite visible in full daylight. It had a fine tail, which the Chinese say was *as long as a street!*

[33] Uncertain.

[34] Elements uncertain. It was *as large as a ball!* and had a tail from 3° to 5° long.

[35] An apparition of *Halley's comet.*

[36] It had a tail several degrees long. Olbers has computed an orbit which agrees well with Halley's, but Méchain's is considered the best.

GEO. W. F. CHAMBERS.

(To be continued.)

ELEMENTARY METEOROLOGY.

THE industry of the thinking portion of mankind, as a matter of course, will cause the different branches of science to advance towards perfection. Already some sciences have become perfect to a degree that even philosophers themselves are astonished at the result of their own labours; and yet were we allowed to see the progress of another century, our present astonishment would be as nothing in comparison with the fresh truths that another generation must undoubtedly unfold. If we look back upon

Beeston Observatory.

Astronomy, we are amazed that our forefathers should have considered our earth as the central orb, around which the sun and all the heavenly host revolved. In the progress of time Astronomy advanced, and the sun became the central body; yet how vague and imperfect were the guesses and surmises of astronomical truths until the immortal Newton, by his discovery of the laws of gravitation, connected all the heavenly bodies together. By a knowledge of these laws, distant planets have been weighed and measured; by a knowledge that each material body is influenced by, and influences every other material body, new planets have been discovered, and truths unfolded so vast that but few are able to understand them.

Photography has made rapid strides, owing to the advanced state of the science of Chemistry; it was but yesterday that the sun was first made to paint portraits and take sketches from Nature. Daguerre discovered that he could render a polished silver plate so sensitive to light, that it would take a picture of anything which was brought to a focus upon it. Then it was ascertained that even a thin film of collodion, spread upon glass, could be made as sensitive as a silver plate, if immersed in a bath containing a solution of nitrate of silver; and that such pictures could be copied indefinitely upon paper. And lastly, M. Niepce announced that he could bottle sunbeams, keep them corked up for months, and then take a picture without any light save that of the bottled sunbeams; that even a common print placed in the sun imbibed sunbeams sufficient to allow it to print a copy of itself in the dark. Then sun pictures could be taken so small that a lengthy document might be contained on a piece of glass no larger than a pin's head. Meteorology, of which we have more especially to treat, has not at present made such vast progress, although it has received the attention of many careful observers; it must still be looked upon as a new science—a science in the condition of Astronomy before the law of gravitation had been discovered—an advancing science, which ere long must become as important a branch of study as astronomy, geology, or natural history.

It is astonishing that so important a

science should have so long received so small a portion of our attention. When we consider that our health, and even life, depend upon the weather, that storms arise and wreck our vessels, that heavy rains inundate our lands and damage or destroy our crops, that in an island depending so much on foreign countries for its supplies, inhabited by an industrious people striving to make the most of the soil, and vying with the world in its manufactories, and in a population far advanced in scientific knowledge in all its branches, and studying the best means of preserving life and health, and of attaining domestic comforts, it is not to be wondered at that meteorology is now becoming an important subject of investigation. Probably the reason this study has been hitherto much neglected is owing to the fact, that weather changes being variable and unaccountable, we are apt to think it impossible to find out the laws which govern them, and perhaps even to doubt the existence of such laws. That laws exist, as powerful as those which connect our earth with the sun, there cannot be a shadow of a doubt. Were there no laws, we should be parched with thirst, and anon deluged with rain—scorched by an overpowering heat of the sun, or frozen to death by excessive frost. Storms of wind would tear up our largest trees and hurl down our noblest buildings; or the air would remain immovable and stagnant, ceasing to carry off the poisonous exhalations from our towns. As it is, however, we have a certain range of temperature and pressure; rain will always fall to a known extent, yet never exceed a certain limit; the air can never be very long at rest, and the velocity cannot extend beyond an ascertainable pressure. Even the clouds, of which nothing can be said to be more changeable, obey a wise law of Providence, by which the earth is shielded in a greater or less degree from our winter's cold and summer's heat. Thus, in summer, the greatest amount of cloud occurs in the afternoon, and the least at night; whilst in winter, the reverse takes place. Our first salutation is in allusion to the weather, and, indeed, the subject is so fascinating, that it is remarkable we find so few practical meteorologists. Time will more rapidly increase the number of observers, for with regard to those who have once commenced in earnest, they rarely relinquish this pursuit.

Government, seeing the importance of such observations, has now its department of meteorology, and each country is adding its quota of observatories and observers. France, Russia, Austria, Holland, Spain, and America are making rapid advances; records are being abundantly made both by sea and land, so that in course of time we may expect to unfold some of those beautiful laws of nature which govern the changes of the weather. There yet requires the discovery of a law which shall bind together all our atmospheric elements, as the law of gravitation binds the heavenly bodies together. Nothing would be more calculated to bring important laws speedily to light than the free use of the electric telegraph to the observers, connecting the more important stations together; and in seed-time and harvest an extensive series of telegraphic meteorological stations, from which farmers might readily learn the probable state of the weather for a few hours, or perhaps days, would really be invaluable to our agriculturists.

In studying the laws of meteorology, or rather, in endeavouring to find out laws, it must be borne in mind that important facts have already been revealed, many phenomena have shown themselves; and, knowing these things, we are enabled to, at all events, place limits to meteorological laws. In the first place, the changes in the barometer are due to lateral displacements of our atmosphere. The air which surrounds the earth is always weighing the same pressure, when weighed as a whole; yet how very different does the

case become if we confine our remarks to any particular locality, for we shall there find constant changes within certain limits. The pressure may be as light as 28 inches, or as heavy as 31 inches, at the sea-level; but it cannot be, for example, as little as 26 inches, or as great as 32 inches. Here, then, we have certain limits for the pressure of the atmosphere; and if the barometer rises in one locality, it must necessarily fall in another, as the pressure from one spot must be added to another. With regard to temperature, a certain degree of heat is given to our globe from the sun, always the same under similar circumstances, but very different in different localities, and varying in a remarkable degree, in the same spot, from time to time. As an instance, the temperature in the shade, in winter, in Great Britain, has been known to be 60° lower in one year than at the same period in another. One great cause in the alteration of temperature depends on the position of the sun with regard to a particular country; the more vertical the sun becomes, the higher the temperature rises, whilst the nearer the sun approaches the horizon, the less heat does that particular locality receive; hence arises our summer's heat and our winter's cold. Knowing this fact, it becomes evident that whilst it is winter in the one hemisphere, it must necessarily be summer in the other. But the winters are not always alike. We have cold winters, and we have those that are warm; nevertheless, the same temperature is received from the sun every winter in each hemisphere. It is simply colder in one portion of that hemisphere than in another; and if heat is robbed from one particular spot, it must become accumulated at another. Thus, we find that last winter was excessively severe in North America, whilst England experienced mild weather. It seems as if the great cold of the polar regions became master of the feeble heat of the winter's sun; and, under these circumstances, we are at the mercy of the winds which bring the cold from the icy sunless districts; they may either carry this icy influence over us, or avert it in another direction.

The same law which governs planetary movements seems to hold good with regard to wind, namely, the *first impulse* which propelled a planet in a straight line directly away from the sun, and the power of gravitation, which exerts an influence in the opposite direction; the two forces combined producing nearly circular motion. As illustration, see Fig. 1, where I J, K L, M N, O P, represent the first impulse, and J I, L K, N M, P O, the power of gravitation, these two influences moving a body in the direction A B, B C, C D, along the arc E F G H.

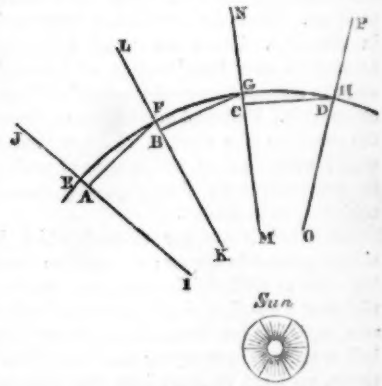


Fig. 1.

The polar currents set in straight lines toward the equator, they meet the resistance of the earth rotating on its axis and become bent, whilst the equatorial currents set in straight lines towards the poles, and are also bent by the earth's rotation, the former creeping along the ground, and rising higher as they approach the equator, and the latter moving at a great height, yet becoming lower as they approach the poles, the two currents mingling together in the regions of variable winds. The same current, from the

same place, does not always pass over the same spot; local circumstances, of which we cannot at present form any correct ideas, operate in causing a variation in the direction of the currents in the variable wind districts. The polar and equatorial currents combine, and, as the one or the other prevails, we have a northerly or a southerly wind. That the wind must always blow in circles is evident from the variability of the wind itself. In England, at the same moment, we can have the wind blowing from every point of the compass. These circles will vary very much in diameter. There are many influences exerted to alter the direction of the wind, and the temperature of the mass of air borne along by it. Hills and mountains can change the direction of a current, whilst a mass of air, of a certain heat, will become altered in its temperature by simply passing over a cold or a warm district.

Moisture is another element which is always present in the air; at one time passing over us as invisible vapour, at another visible as a cloud, and at a third discharging rain, or, if at a low temperature, frozen into hail or snow. In studying the clouds attentively, we learn many curious facts with regard to their forms and positions. Clouds chiefly move in circles, and this is seen from the tendency they have to form in straight lines, *i.e.*, converging to a point in the far distance, and the reason they are seen as straight lines is owing to these circles having a diameter, too large to be seen, curved in our limited view of them. Lines of cirri, converging to the north near Nottingham, have been observed at the same time converging to the north-west at Manchester. Clouds have been said to owe their form to currrents of air, and, in some degree, perhaps, this is true, as is shown by the clouds presenting their pointed ends to the wind; yet there is another more powerful force exerted, a power *inter se*, which, in rare instances, has been well shown from this observatory. Clouds have been seen to be moved in one direction by the wind, and, at the same time, currents (within the cloud itself) moving the mass of the cloud in an opposite direction. See Fig. 2, where C is a cloud moving in the direction of the arrows, A A, having a spiral progressive motion in the direction of the arrows, B B.

Fig. 2.

Whilst writing this article, a very singular example was noticed. A cumulus (Fig. 3) floated in the direction A A, having two motions within it at its two extremes, the one in the one direction, B B, and the other in the opposite direction, D D.

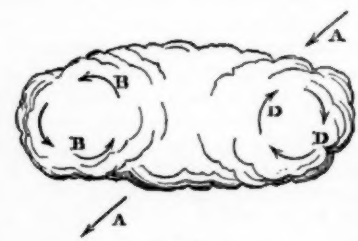


Fig. 3.

This is also shown in thunder-storms, when the whole cloud can be well observed; instead of the cloud discharging rain from all portions, it will be discharged only from a particular part (see Fig. 4). It is also shown by the same cloud discharging rain from one portion and hail from another. In most storms there is a belt of frozen rain (or hail), and this is, at the first portion of the storm, probably owing to the colder heavier air rushing to the

front. It might be thought, therefore, that hail should fall before any rain, and this would be the case were it not that the first edge of the cloud had to meet a warmer cur-

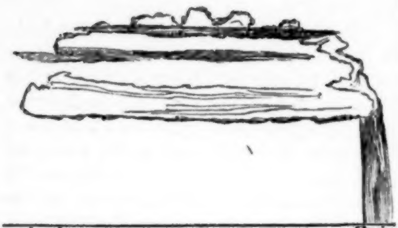


FIG. 4.—Thunder-cloud.

rent, causing the hail to melt. If a thunderstorm (where the zone of hail passes vertically over a place) be attentively watched, it will be seen that rain falls first, followed by half-melted hail, after which the hailstones become larger and harder until a maximum is reached, after which they as rapidly decrease in size and hardness, and at last are succeeded by rain. The hail-storm is a compact mass at the front of the cloud; it cannot be a circular belt around it, otherwise, before the termination of the storm, another hail-shower would occur; and this seems never to be the case.

However, we have said enough, introductorily, to convince all thinking men that a wide field of investigation is open before them, which, by careful culture, is capable of yielding a plentiful rich harvest of truth. We, therefore, propose to take up each branch of the subject, and describe how observations may be best made, which instruments it is most desirable to use, and what precautions are necessary, in order to render the records useful to science and mankind.

E. J. LOWE.

Beeston Observatory.

A PLAYTHING OF THE TIDES.

A PLAYTHING of the tides—a plaything of the waters! Truly so. A tennis-ball of flint, which the never-sleeping waves have bandied to and fro for many a long series of years. But, seriously, what is it? We have already said that it is a ball of flint; but, to speak more correctly, a ball it was before chance threw it into our hands, by the agency of which its exterior integrity became sadly, yet happily damaged.

Forgetting its antecedent condition as a plaything, driven onwards and backwards, and rolled round and round by many a flow and many an ebb, let us place it before our readers. We can only do so by delineation.

Who, then, we would ask, looking with a hasty glance at our "*fac-simile,*" and for the moment forgetting all about its silicious composition, but would say—"This is a petrified fruit, surely? Why, there are the plain indications of a fruit-stalk, from which elevated fibres extend over its rotund surface. But what a strange fruit, or perhaps kernel; how reticulately rugose its surface; and what are we to say to its apple-like investment, and the cavity within which the kernel is lodged, adherent by the fruit-stalk only?"

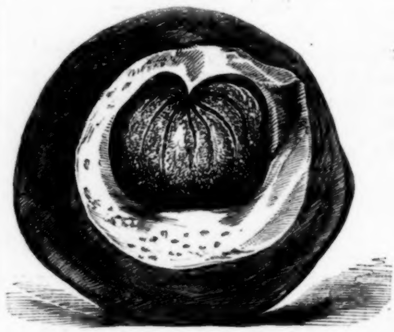
Now, to speak the truth, some such momentary idea flitted across our own mind as the kernel was revealed by a smart blow, striking off a portion of the thick investment. It was but momentary, and we smiled at our want of reflection; yet there was some excuse for our precipitancy.

One summer's day, we were sauntering

along the margin of the sea, below the cliffs at Margate, on which the Infirmary stands, and from which cliffs we had, some months ago, extricated a portion of the chalk impress of a gigantic and beautifully-marked ammonite. There, as we have said, were we sauntering, now and then stopping to look at a crowd of sandhoppers (*Talitrus*), as our feet disturbed them from their shelter under a mass of dried sea-weed; now, perchance, lingering to watch a group of little wandering crabs hurrying to the nearest pool, or a hermit-crab in that little sheet of water prowling about intent on prey; and then, arresting our steps to listen to the hoarse grinding music of the inflowing tide, and follow the advance of the unnumbered pebbles, as the waves idly played with them, rolling the lighter fragments over and over, as they have done for ages, wearing down (flints as they are) the angularities which they originally presented; for when the chalk-slip in which they were embedded fell, its lighter particles became by degrees washed away, and these rigid flints remained to undergo the ceaseless action of the alternate tides.

Thus, in careless mood, such as follows long sickness, and thus pleasing our fancy, did we see the orbicular pebble in question gently roll up the shingly beach to our very feet. We stooped, and took it up. "Ball of ocean, with which the wild waves are playing," for so we mused, "how long is it that thou hast thus served for their sport?—how long is it since, a silicious jelly, thou becamest hardened in a deep cretaceous bed, and what have the waves done with thee since they undermined thy native cliff?" Ask of the mummy the history of the Pharaohs of old. Why, the very stones of their buildings discover, to the test of the microscope, organic forms; nay, the sands of the surrounding deserts are replete with fossil infusoria. That mummy walked upon the relics of a world gone by. Vague is the word "antiquity;" it applies only to man. Would we learn, we must ask of the great globe itself. Is it silent? No; it teaches by Nature's own *lithoglyphs*, which speak—oh! how truthfully and how impressively—preaching to us our own nothingness, and the mystery of time.

Well, we held the pebble in our hand. It is difficult to say by what impulse we were induced to split it. Long sickness makes the mind languid, and we had no hammer with us, but strike we must. We looked out for a large block imbedded in the sand; we soon picked up a fragment of flint which seemed serviceable, and placing the pebble on the block, struck smartly. The flint ham-



mer, although it broke, did its work well. It laid open a kernel, in a neat and definite little chamber, hollowed out in the imprisoning wall of silex. The fissured portion showed a white and glossy surface—a sort of opaque porcelain—dotted with blue (the result, perhaps, of some metallic oxide), and its thickness proved how good a preservative it had been for the delicate granular kernel, with its superficial threadlets diverging from the apparent fruit-stalk.

A fruit—a kernel? No! Yet a kernel, and that kernel a sponge.

Yes, this kernel is evidently one of the sponges of the flint. Of many of these the

beautiful tracery is easily revealed on thin laminæ, by the aid of a moderate glass. But these sponges permeate the very flint itself, are preserved in flint, and only manifest themselves under peculiar circumstances. But here we have a nodule of flint, with an internal chamber, the nidus of a delicate fruit-like body, which we regard as a fossil sponge. It is in what is termed the upper chalk deposit that flints abound. Oftentimes we see them laid in courses at regular intervals, as if the skilful hand of the mason had arranged them. Examples of this kind occur in the Isle of Wight.* Such, however, is not the case as regards the chalk-cliffs on the Kentish side of the sea, along or below the estuary of the Thames. In these cliffs we find delicate shells and echinoderms (some filled with chalk, others a solid mass of flint), irregularly scattered, with occasional ammonites; while in the chalk pits near Gravesend, we have, in addition, silicified sharks' teeth and various other relics, including the spines of echinoderms, and corals in abundance.

Let us then suppose our flint nodule to have proceeded from this upper chalk deposit, and then comes a question—Where was it, and from what did it hang, when the fluid or semifluid silex enveloped it? Was it a tenant of some rift in the chalk-rock itself? Are the silicified sponges in their primitive seat? It cannot be. There has been destruction, there has been a turmoil and *melée;* then a quiet subsidence, a gradual deposit of chalk through a series of ages, an infiltration of fluid silex—there filling up echinoderms, there inclosing sponges, there impregnating the teeth of sharks and other fishes, and there simply consolidating into masses which give no trace of organic existence.

We need not say that the great deposit of chalk took place by degrees at the bottom of a deep sea, nor shall we here analyze the chalk itself; far too wide would the field be for our prescribed limits; we pass the subject by.

* The arched rock in Scratchell's Bay.

To revert to our specimen: How happens it that the flint has not tightly embraced the kernel-sponge, but has left, as far as we can probe, an interval, so as to form a chamber, in which, except at the stalk, it seems to remain free? Did the living gelatinous investment of the sponge once fill up the vacuum, and then perishing, waste to a mere nothing? Conjecture fails us.

We have not broken the kernel, the gray-tinted, granular superficies of which, with the diverging fibrous lines, our sketch accurately depicts, and therefore cannot positively assert that its interior is purely silicious; we presume, however, that such is the case, and should be sorry to see it tested by experiment.

W. C. L. Martin.

MOSSES IN FERN-CASES AND AQUARIA.

Mosses, properly selected, would form most valuable, as well as attractive objects in the fern-case and aquarium. In the former, especially, Bryum pyreforme would thrive most luxuriantly, and is valuable to use as a surfacing to plants in pots, or even among ferns in the open air, as it prevents the surface of the mould from drying, and its root are not strong enough to rob the plant.

In the aquarium many would flourish, as Fontinalis antipyretica, Cinclidotus fontinaloides, Hypnum ruscifolium, filicinum, fluitans, riparium, and Bryum punctatum; and the following most lovely species are worth a trial: Hypnum alopecurum and dendroides, Bryum hornum, roseum, and ligulatum; the latter will most decidedly retain their beauty for some time if they do not vegetate.

F. Y. B.

COINS OF THE SELEUCIDÆ, KINGS OF SYRIA.

A COMPLETE cabinet of ancient coins comprises so vast an aggregation of specimens, that its formation is far beyond the means of the great majority of those who have collected or hoarded a few of these interesting monuments. It is in national museums or libraries alone that duly classified series of ancient coins of every class can be attempted. Some few private collections, as the Hunterian, the Pembroke, and the celebrated Thomas cabinet, were indeed wonderfully rich in many very distinct branches; and yet, as embracing examples illustrating the whole of this most important and interesting branch of archæology, they were necessarily inferior to many of the poorest public collections. It is therefore evident that any attempt to form a general cabinet with anything like tolerable completeness, would involve an outlay both of time and money far beyond the convenience of any collector. Hence it may be suggested that some special department should be selected by the young numismatist, to which he should confine his chief attention. By this means, and by beginning early and seizing the happy opportunities that never fail to occur from time to time, some single branch of the subject may be so completely illustrated as to form a very interesting, if not important cabinet, illustrative of a special period or dynasty.

As an instance, I may allude to the cabinet of Roman "Large Brass," formed by Captain W. H. Smyth. This fine collection (the descriptive catalogue of which, by its possessor, is one of the most interesting and instructive numismatic works in the English language) consists only of specimens of the Roman copper coins of the larger class, from the reign of Augustus, B.C. 42,* to that of Saloninus, who was assassinated in the year 259 A.D.

In the Roman series a collection of the denarii, or standard silver coinage, might be made of the same period, at but little more cost. Some of the types are very interesting, and it would have the advantage of enabling the collector to continue his series down to the time of Constantine and his family, or even to a period later than that, at which the larger class of brass money dwindled, and gradually disappeared with the decline of the empire.

The old French numismatist, Le Vaillant, made a special collection of the coins of the Macedonian kings of Syria, and our own antiquary, Gough, has principally restricted himself, in the numismatic department of his archæological researches, to the same subject, his volume on the coins of the Seleucidæ being one of the finest works of its class.

From that series of coins, indeed, a most compact and complete cabinet may be formed, and its being limited would enable almost any enthusiastic collector, who had patience to see his cabinet increase slowly year by year, to get together, in a comparatively short space of time, a very respectable cabinet, illustrative of the establishment, the flourishing period, the decline, and extinction of this important dynasty. Another feature in favour of this subject (and some others of a similar class to be afterwards alluded to) is, that the whole period embraced belongs to the finest era of monetary art, nearly the whole of the coins of every reign, except a few of the last, being of fine execution, and some of them remarkably splendid works of art, especially those of the reign of Antiochus the Great. The silver tetradrachms, or pieces of four drachmæ, are the finest coins of the series; but a collector wishing to get his

* The date of the battle of Philippi.

illustrative series together economically, may avoid these, when rare, and consequently expensive, and put up with a silver coin of smaller dimensions, or even with a copper one—copper coins of some of the reigns being plentiful, and of good execution. The following is a brief outline of the origin of the dynasty, and of the general character of the coins of each reign.

The death of Alexander the Great took place in 323 B.C., soon after his total subjection of the whole of Western and Central Asia. The vast empire had been divided by the conqueror (after the oriental manner) into satrapies, over which those Macedonian commanders who had most distinguished themselves in the conquest, were appointed the respective governors. The death of Alexander was no sooner known in the different provinces of the vast empire, than, as if by a given signal, there began a general struggle for the supreme power. Philip Arrhidæus, Alexander's half-brother, who was appointed regent during the minority of Alexander's infant son by the celebrated Roxana, was utterly unequal to the difficulties of the position, and a general war ensued, in which much of the best blood of Greece and Macedonia was spilt. The subjection of the Asiatic races was, however, so complete, that no attempt to resume their independence was attempted; so that, eventually, the empire was divided (for a time) mainly between four of the most successful of the combatants—Lysimachus obtaining a large region, embracing Thrace and the adjoining provinces, Cassandra Macedonia, Ptolemy the noble province of Egypt, and Seleucus the whole of Central Asia, including Babylonia Proper, Assyria, Bactria, to the confines of India, and westward, the whole of Syria to the coasts of the Mediterranean and the frontiers of Egypt. Two only of the chiefs who thus succeeded in conquering a throne became the founders of permanent dynasties—Ptolemy in Egypt, and Seleucus in Syria. Seleucus I., surnamed *Nicanor* (the victorious), no sooner felt himself firmly established, than he founded several cities, to form the principal centres of his far-extending dominions. Of these Antiochia (Antioch) was intended to be the metropolitan, as being near to the Mediterranean, and therefore in a position to command ready communication with Europe and with Egypt, Babylon being deserted as too remote for the seat of a dominant power whose main support and prestige was drawn from Europe. It was as the ruler of the ancient kingdom and capital of Babylonia, however, that Seleucus founded his claims as ruler of the vast regions of the East, for the possession of Babylon gave to his power an air of stability among his Asiatic subjects. It was, doubtless, to aid this feeling that he caused coins to be struck, on which the chief characteristics of the great symbolic winged bulls of the ancient palaces of the kings of Babylon (still perfect in the time of Seleucus) were introduced. This, probably, took place when he formally assumed the regal title—about the year 312 B.C. On these coins, which are very rare, only four or five specimens being known, the new king of the East is represented wearing a helmet, on which the horns and wings of the Babylonian bulls form the chief ornament. The human-headed bull, as a symbol of Babylonian sovereignty, is thus symbolized in the device of the obverse of the coin engraved below, the head being, in all probability, an idealized portrait of Seleucus. It was at this period, as is well known, that princes first ventured to place their portraits on the public coinage of the state, only the images of the gods or the device of the national signet—generally consisting of some object sacred to the gods—having up to that period been used upon national money. Alexander was the first who, in the character of "Hercules"—from whom he claimed descent—caused his own features to be imitated in the representation of this mythological deity; but did not at-

tempt to place his own portrait, in his simple character as sovereign, on the coinage. Lysimachus followed out the hint, when he established his kingdom of Thrace, by causing his features to be introduced as those of the horned Bacchus on the coins which he issued. The coin of Seleucus Nicanor, engraved as one of our illustrations, may be taken as another example of the transition from the images of the gods to those of princes on the national money.

Suidas, a Byzantine author, writing in the 9th century, tells us that the horn of a bull, etc., found on the coins of Seleucus Nicanor, was used in allusion to the recapture of a bull which had escaped during a sacrifice which was being performed by Alexander. This, however, as a statement made above a thousand years after the reign of Seleucus, is not to be much depended upon, and is less in accordance with the spirit of the time than the supposition which I have adopted in preference. The reverses of many of the coins of the Seleucidæ have for type a very elegantly-designed figure of Apollo, adopted as a family device by the Seleucidæ, in allusion to a dream of the mother of the first Seleucus, who, in the vision, was informed that her child was the offspring of that deity. A ring is described as having been found in her bed bearing the device of an anchor, and the child was, it was said, marked on the thigh with the same figure, which continued (as Justin relates) to be found on all the true descendants of Seleucus, even to the last of the dynasty. The device of the reverse of the coin Fig. 1 is, however, formed of a figure of Victory crowning a trophy, in allusion, no doubt, to the great victory over Antigonus and Demetrius, at Gaza, which completely cemented his power in the West, and reopened his interrupted communications with Babylonia. It is this epoch, in fact, which forms what chronologers term the Seleucidæan epoch, their dynastic dates being calculated from that period; and nearly all the coins bear dates which mark the number of years from that time to the epoch at which the coins of subsequent eras respectively were struck. The inscription on this coin is simply ΒΑΣΙΛΕΩΣ ΣΕΛΕΥΚΟΥ (of the King Seleucus). The small Greek numerals, and a single letter, have reference to a date, and to the name of the city at which the coin was struck, or to the name of the magistrate having charge of the mint.

Fig. 1.

The coins of Seleucus Nicanor which are most usually found, and with which most collectors must rest contented as a monument of his reign, are those struck by him before he assumed the title of king, and on which he used the types of the coinage of Alexander, the head of Hercules clothed with the lion's skin, but with the addition of wings behind the ears. Of this type some have only the simple name of Seleucus on the reverse, while others, those struck at a later period, have the title of king. Some of them, especially the copper, have a bull on the device of the reverse; and there are

other varieties, some having a head of Jupiter for obverse, like those of Philip II. of Macedon. The coin engraved (Fig. 1) is a silver tetradrachm, or piece of four drachmæ. Seleucus Nicanor was assassinated, after a long reign, by his brother-in-law Ceraunius, in 282 B.C.

His successor, Antiochus I., was surnamed *Soter*, or Saviour, in consequence of his victory over several hordes of Celts, who threatened to overrun the whole of Asia Minor. This prince was the first of this dynasty who caused his own portrait to be placed, unidealized and unaccompanied by any sacred symbols, on the public coinage of the newly-established empire. On the reverse the device is generally the figure of Apollo, as on the coins of Antiochus the Great, engraved here (Fig. 2). The legend is ΒΑΣΙΛΕΩΣ ΑΝΤΙΟΧΟΥ. He died in 261 B.C.

Fig. 2.

Antiochus II. was surnamed *Theos* (the god), on account of his delivering the Milesians from their tyrant Timarchus. He died by poison in 247 B.C. His coins were distinguished from the preceding by the device of the reverse, which is generally a finely-executed figure of Hercules, seated, and leaning on his club. These coins are very fine.

Seleucus II. reigned from 247 to 227 B.C. His coins have a portrait on the obverse, and a fine figure of Apollo leaning on a tripod on the reverse, with the inscription ΒΑΣΙΛΕΩΣ ΣΕΛΕΥΚΟΥ.

Seleucus III. reigned from 227 to 223 B.C. His coins have the same devices and inscriptions as those of his father; but may be distinguished by the youthful character of the portrait, as he was assassinated at the early age of 20.

Antiochus III., surnamed the Great, was the brother of the preceding, and reigned from 223 to 187, B.C. The coins of this prince, the antagonist of the Romans in the East, and the protector of Hannibal, who took refuge at his court, are perhaps more numerous than those of any of his predecessors or successors. A very interesting collection might indeed be formed of the coins of his reign alone. The series exhibits the features of the prince, from early youth to advanced age, in a fine series of portraits, which are remarkable as mere works of art; while the series of the reverses are very various, that engraved above being the most common. It represents Antiochus in the early years of his reign, and is a silver tetradrachm. The gold coins of this reign are large and fine, but it is on the copper and small silver that are exhibited the greatest number of devices.

Seleucus IV. reigned from 187 to 176 B.C. There are no good coins of this reign. The small copper have the prow of a vessel for reverse, with the name and title as usual.

Antiochus IV. (from 176 to 164 B.C.) The coins of this prince are remarkable as being the first which bear the surnames of the prince. They run as follows:—ΒΑΣΙΛΕΩΣ ΑΝΤΙΟΧΟΥ ΘΕΟΥ ΕΠΙΦΑΝΟΥΣ, "The king Antiochus, the god, the illustrious." Some of

the copper have a fine head on the obverse, and a well executed eagle grasping a thunderbolt on the reverse. The small copper have the portrait with the radiated crown—the first time it appears on this series.

Antiochus V. (from 162 to 150 B.C.) His coins may be distinguished by his surname ΕΥΠΑΤΟΡ (Eupator).

In the space of this article it will only be possible to give the names and surnames of the remaining members of this dynasty. Demetrius I. (Soter) reigned over a portion of the empire, from 162 to 150 B.C.; Alexander Bala, from 150 to 147 B.C.; the reigns of Demetrius II. (Nicator), Antiochus VI. (Dionysius Epiphanes), Diodotus, Triphon, and Antiochus VII. (Sidetes), occupy together, in a time of general disturbance, from 147 to 125 B.C. Alexander Zebina reigned from 125 to 124 B.C.; his portrait has sometimes a crown of rays, but sometimes a simple fillet. Seleucus IV., who reigned for a short time, 124 B.C., has left no coins; Antiochus VIII. (Grypus) reigned from 124 to 76 B.C., over a portion of the kingdom; Antiochus IX. (Cyzicenus), from about 111 to 91 B.C., reigned in some of the provinces. Then follows Seleucus VI. (Epiphanes Nicator), from 96 to 94 B.C. Antiochus X. (Eusebes, and on his coins Philopater), Antiochus XI., Antiochus XII., and Demetrius III., reigned alternately or simultaneously from 96 to 83 B.C. Most of the coins of these last princes and pretenders have for reverse a sitting figure of Jupiter, similar to that on the tetradrachms of Alexander the Great, but poorly executed, and are of base metal. Tigranes the Armenian reigned over great part of the Syrian dominions, from 83 to 69 B.C.; and his coins with the portrait, wearing the curious Armenian cap or crown, are very remarkable. Antiochus XIII., from 69 to 65 B.C., about which period the whole of the remaining Asiatic dominions of the kings of Syria were declared a Roman province by Pompey. Most of the coins of this series may be easily recognized by a young numismatist after a little experience. The dates of the Seleucidæan dynasty on many of them at once settle the difficulty; and in the earlier part of the series the surnames are also distinguishing features. But it is only the complimentary surnames that are found on the coinage, many of those by which they are historically known being popular appellations, not officially acknowledged. The monographic names of cities are another means of identification; and after a time a collector will get to know the portraits, which are all evidently careful likenesses.

Since the foregoing was written, the treasures of the celebrated numismatic cabinet of the late Lord Northwick have been dispersed, and among them some noble gold coins of the regal series of Syria. A very rare one of Antiochus V. (Eupator), weighing $255\frac{4}{10}$ grains, brought £18 10*s.* It was formerly in the Thomas collection, at the dispersion of which it was sold for £10, proving that really rare coins, in *fine condition*, are rapidly increasing in value. A gold coin of Demetrius II., bearing the date ΞΠΡ (186), sold, with some others, for £21; the date being interesting as that of the year of his assassination at Tyre. In the confusion of successions, the same date occurs on money struck by his wife Cleopatra, and on the coins of his son, Antiochus VIII., and Alexander II. But the great gem of the Syrian series in this collection was the splendid gold tetradrachm (weight 257 grains), struck by Cleopatra, the mother of Antiochus VIII., during her regency. This coin was described in the catalogue as "rare to excess." Mionnet, in his fifth supplement, cites the Northwick cabinet as containing this rare coin, of which he only knew one other example. After considerable competition, the numismatic prize was purchased for the British Museum for the sum of £240!

H. NOEL HUMPHREYS.

HERBARIUM OF MOSSES.

APPARATUS.

In the midst of wintry desolation, how the eye is charmed by the vivid freshness of the tufts of emerald moss that beautify the clefts of the rocks, the decayed hollows of old stone-walls, and the buttresses of gray ruins. The study of mosses is attractive beyond the unique beauty of the plants, for every investigation of their structure reveals a wonderful system of vegetable mechanism, which under the microscope assumes the most varied and artistic forms, often as geometrical as snow-crystals, and very frequently being striking resemblances to familiar works of art. A simple Coddington lens is sufficient to determine most of the species, and we are invited to search them out by the romantic situations in which they are usually found; nay, they make dreary places romantic for a time, and carpet the earth with verdure when most other forms of vegetation have yielded to the rigours of winter. But the mosses are not exclusively winter plants; every month in the year presents us with species in growth and fruit, and there is always some such to be sought by the collector. They are, nevertheless, in their highest perfection in the midst of frost and snow, and at this season of the year the beginner need not search far to discover an abundance of the most interesting and beautiful species.

For collecting mosses, the following apparatus will be required:—1st. A water-proof bag, of oilskin, gutta-percha, or some such material, for aquatic species. 2nd. A small-sized dinner-knife, which should be provided with a leather sheath as used for scissors. This, from its long, thin, and flexible blade, is far preferable to a pocket-knife, to peal mosses off trees, palings, walls, etc. 3rd. A small hoe-shaped blade, fitted to a short tube, like an elongated thimble, with a bayonet-joint. Any clever workman would suggest the mode of constructing this instrument, which should be made to fit a walking-stick or umbrella, or it may have a handle made on purpose (Fig. 1). 4th. A few unglazed holland bags, say six, the largest six inches long, and four wide, the smallest three inches long and three inches wide. These may be fastened with strings, but I prefer two buttons, as shown in the engraving (Fig. 2).

Fig. 1.—The Hoe-blade.

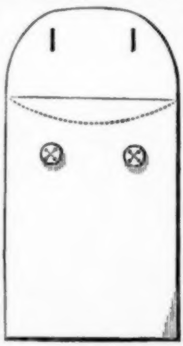


Fig. 2.—The Bags.

5th. *The Drying Press.*—This is formed of thin strips of wood, so arranged as to allow a free current of air to circulate between the layers of specimens and the papers placed between them, to facilitate the escape of moisture. The outside frames should be made with two stout cross-bars; the two outer strips one inch wide, the inner strips half an inch wide; the spaces between one-quarter of an inch; the inner frames to be composed of two layers of strips all half an inch wide, with quarter-inch spaces; with three cross-bars between, to which both layers of strips are fastened by a screw passing through the whole; the end

cross-bars one inch wide, the centre half an inch. Two light straps to pass over the cross-bars, to fasten them, will keep the whole together compactly when filled with specimens in process of drying (Fig. 3).

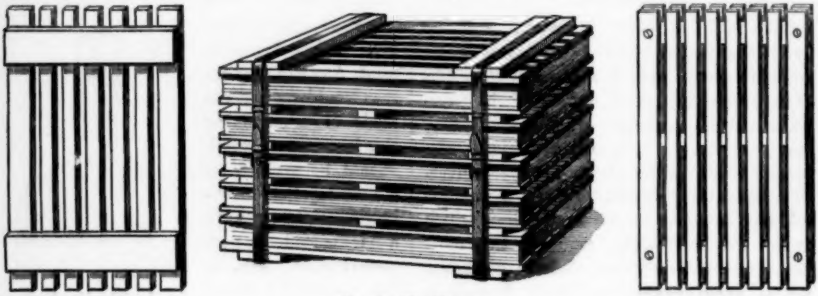


FIG 3—The Press.

6th. An apron should be provided, made of oil or American cloth, twelve inches wide and twenty inches long, divided into parti-

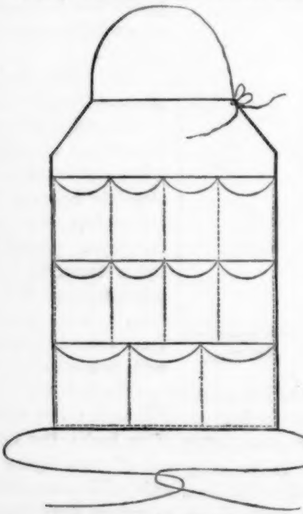


FIG. 4.—The Apron.

tions like a lady's needle-huswife, as represented (Fig. 4). This being water-proof will keep the specimens clean and in good order, and, when the day's collecting is completed, can be rolled up, and carried home. I can say nothing in praise of vasculums, as experience has taught me to avoid, when engaged in collecting, whatever is weighty or cumbersome; and if once the species get mixed, the loose dirt spoils their beauty, and they can never be examined with that comfort, or preserved with that delicacy and beauty, which are so characteristic of this order. In fact, as a *rule*, vasculums are well calculated to *damage*, not preserve our most delicate plants.

7th. A pair of surgeon's dissecting forceps (Fig. 5), for examining *minute* specimens,

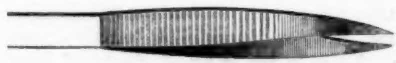


FIG. 5.

and removing them from foreign objects, or the water in which they are immersed before drying.

HOW TO COLLECT THEM.

A final preparation before starting, is to be well protected about the feet and legs, for to get mosses you must not mind an occasional plunge into a bog. Choose a damp day, or, better, a clear day soon after a heavy rain, for it must be remembered that in dry weather many mosses, as Poly-

trichum undulatum, Pterogonium Smithii, and many of the Bryums, shrivel and become unsightly and much altered in appearance; but dry weather should not be considered as altogether unfit for collecting, for such as Pterogonium Smithii I consider improved by its curly appearance. In exploring for mosses, you will find Hypnum riparium abundant on the wooden gates of locks, mill-dams, hatches, etc.; Fontinalis antipyretica, growing in waving or feathery plumes from the bottom and sides of tolerably deep streams; the Polytrichums, abundant on heaths and sandy banks; the Orthotrichums, on stones and trunks of trees; the Phascums, forming patches of reddish-brown, or green, with yellow dots like seed, on the surface of the earth; Weissia calcarea, forming a blackish-brown stain on the surface of chalk in pits and railway-cuttings, and so minute as to compel the collector to chip off the surface of the chalk to get the specimens. The Dicranums and Hypnums may be found everywhere, from the sides of our wells to the walls of the house, the tops of trees, and on lofty mountains. Bryum argentium, I am told, is found all over the world. It is abundant on Westminster Bridge, and on waste grounds where houses are building, or have lately been built, between the stones in unfrequented squares, and on many walls in and near London.

While collecting, the hoe-shaped blade, attached to the stick or umbrella (Figs. 6 and 7), will be found especially useful for loosening Orthotrichums, and others that grow on trees above your reach. The specimens may generally be caught in the hand as they fall. It will also be useful for pealing them off the sides of walls, banks, etc.; and even on the ground it will often save stooping or kneeling where the soil is damp. Many may be reached and removed from under water, and from wet banks and the sides of deep ditches, with a piece of stout iron wire, crooked to form a hook, and tied on to the stick.

ARRANGING THE SPECIES.

The species should be kept separate as far as is possible, and should be stored in the apron or the bags, according to their relative sizes and delicacy of structure. On returning home, the first task should be to endeavour to name them; if, however, we intend

FIG. 6.—Blade on Stick.

FIG. 7.—Blade on Umbrella.

leaving the naming to some friend after the specimens are dried, we must put the date of collecting and district with each, and if we have more than we can readily dry, expose the others to the air of a warm room, thinly spread on blotting-paper, and when dry may be placed away and pressed at any future period, as will be explained presently.

DRYING IN THE PRESS.

Having picked the specimens over loosely, take a large sheet of stout brown paper, turn out the mosses upon it, and carefully remove from them any dead leaves and other rubbish that may be mixed with them, throw them into a basin of boiling water, and, with your drying paper and press beside you, remove each specimen with a pair of surgeon's dissecting forceps, and place it on the paper with all the water it has absorbed. It requires the greatest care to prevent them shrivelling, even when pressed, especially if they are changed in a warm room. The press is a compact little apparatus, and very light, should be made of mahogany or cedar, nine inches long and five and a half wide, fastened by two light straps, as seen in the illustration (Fig. 3); it may stand on a footstool in front of the fire, or in any warm corner near the fire-place.

The specimens should first be changed in about twelve hours after having been put in, and again every second day until dry, and take especial care not to press too tight, or the beauty of many will be destroyed.

MOUNTING FOR THE HERBARIUM.

When dry, the duplicates may be kept between folded sheets of waste paper, the name of each (or what information may be deemed proper) written at the left-hand bottom corner; when mounted it should be on the stoutest note paper, largest size, and named as the duplicates.

Very little expense or skill is required in forming a moss herbarium; the plants being so small, little trouble is involved in mounting them, nor is it absolutely necessary to poison them, as there is little for insects to feed upon.

At present I have been addressing the amateur botanist, whose chief aim is to have a well-named collection. There may be others, however, whose chief delight is collecting, intending, as I before mentioned, to get some botanist to name them, or who intend to use them to form devices, or in the manufacture of fancy articles, for which they are most appropriate from the many delicate forms in which Nature has fashioned them. Besides this, the species most suitable for ornamental uses are abundant, and may be easily dyed in a great variety of colours. To use mosses for such purposes proceed as follows:—

COLLECTING FOR FANCY WORK.

Have a large unglazed holland bag, choose the driest weather, collect as many as you require (or as many as you can find) of every species you meet with, put all together into the bag carelessly, rolling up in scraps of paper the Phascums and such as are removed with the dirt. On reaching home, if any are in the slightest degree damp, let them be dried thoroughly before a fire, or by exposure in a warm room. The collections of a day, week, month, or year, may be all packed together in a bag or box provided with partitions to separate certain districts or periods of collecting; they may be so kept for years if necessary, and the whole or any portion may be properly dried at any time that may be convenient. By maceration in boiling water, and pressing in the ordinary way, many will come out of the water in all the freshness and beauty of form they possessed when growing, years after collecting.

This is a most valuable and important fact for the tourist, as, while travelling, many of the most handsome and delicate species, which are only found in certain localities, may be collected in abundance, which otherwise must be neglected altogether, and a skilful botanist would at all times be able to separate a majority of such species. I could in a brief space of time separate 100 British species, allowing any one previously to use their skill in mixing and confusing them.

FREDERICK Y. BROCAS.

—o—

HOW TO USE THE TELESCOPE.

"Telescope Teachings:" A Familiar Sketch of Astronomical Discovery. By the Hon. Mrs. Ward.

A rudimentary book on the practical study of astronomy, and as such it would be impossible to find one more attractive to the novice. Indeed, the work is well calculated to make astronomers of those who have not studied the subject. Mrs. Ward shows, in a clear manner, how very much can be done at a small cost, both in labour and money. Many of the plates (of which the work is profusely illustrated) are admirable pictures, faithfully executed. Donati's Comet and the Eclipse of 1858 may more especially be noted; in fact, those who desire (and who does not?) to have the splendid comet of that year brought truthfully before them, should by all means possess this book. Great credit is due to the authoress, to the artist, and to the publisher; each have done their part well, so that the work must have, as it really deserves, a great circulation.

We extract, as an example of the author's method, the following directions for the observation of the spots on the sun by means of the telescope:—

"We must place a piece of dark-coloured glass before the eye-piece of the telescope, as the sun is far too bright to be looked at without this protection. There are two other little precautions which we would recommend to the observer: firstly, to point the telescope by observing its shadow on a piece of paper, held to receive it; when this shadow is perfectly round, it will be found that the instrument is exactly pointing to the sun; secondly, prepare a flat piece of pasteboard, with a hole cut through it of the diameter of the telescope, and when the instrument is properly adjusted, slip on the pasteboard to screen the unemployed eye and the head and face from the heat of the sun. The first precaution is recommended to save the observer from being dazzled in vain endeavours to 'hit the sun' in the ordinary way, and both are more easily and quickly done in practice than in description.

"Looking now through the telescope, should the dark glass used be of a reddish shade, we shall see a round orange-coloured disc in a black sky. On this disc there are generally a few black spots, somewhat resembling small blots or splashes of ink. When examined with care the larger spots prove to be not uniformly black, and not circular in shape, but of two dark shades, and of irregular outline.

"It is sometimes practicable to look at the sun through a fog or thin cloud without using the coloured glass. Its disc then appears white, and the spots are of two shades of brown.

"The opinion generally held by astronomers concerning these spots is, that they are the *comparatively dark solid body of the sun*, laid bare to our view by immense fluctuations in its luminous atmosphere; that the sun has at least two atmospheres, upper and lower, and that the *darker* part of the spots is where the sun is seen through a rent in *both* layers of atmosphere; the *lighter*, where one layer still covers it. Recent observations have indicated that there are *three* gradations of shade, in some spots at least, the centre being the darkest.

"The solar spots are not permanent. When watched from day to day, they are observed to enlarge or contract, to change their forms, and at length to disappear altogether; and new ones appear where pre-

viously there were none. These changes can be detected with a very small telescope. Another phenomenon on the sun's disc is the occasional appearance of certain branching streaks of lights on its luminous surface, curved in shape, and distinguished by their superior brightness. These are called *faculæ*, and are often observed in the neighbourhood of great spots, or on parts of the solar disc, where spots shortly afterwards break out. These have been supposed to be ridges of immense waves in the luminous regions of the sun's atmosphere, indicative of violent agitation in their vicinity.

"With powerful instruments the whole surface of the sun may be seen to be finely mottled with minute dark dots or pores, which fluctuate in their appearance like the rest of the markings.

"The solar disc can be exhibited in a very agreeable manner by holding a screen or sheet of paper at a proper distance from the eye-piece of the telescope, and slightly altering the focus of the instrument, when the bright image of the sun will be shown, with all the spots distinctly appearing. The effect will be heightened by darkening the room, as, for instance, by having a hole made in the window-shutter for the telescope, and closing every other aperture. The *faculæ* show particularly well in this way, and their presence may often be thus detected when the fatigued eye has failed to observe them by a direct scrutiny. With this contrivance, however, the spots will be reversed, as in a camera obscura; but they may be noted down on paper, and afterwards traced on the other side, when they will appear in their true positions.

"A persevering observer in Germany (Schwabe) examined the sun's disc for twenty-four years. He found a great variety, in different years, in the number of days in which the spots were to be seen. There were but *two days* in 1850 that he failed to see them out of three hundred and eight days in which he looked at the sun; in 1843 there were one hundred and forty-nine days without them, out of three hundred and twelve. He did not think that the spots have (as has often been imagined) any influence on the temperature of the year.

"The changes in these spots are truly surprising when we consider the size of the sun; and its size is known with considerable exactness, having been calculated by comparing its apparent diameter with its known distance."

METEOROLOGY OF JANUARY.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1842	—	12·5	—
1843	55·0	16·5	1·6
1844	56·0	23·0	1·5
1845	53·0	17·0	1·3
1846	55·5	29·5	2·0
1847	46·5	24·5	2·1
1848	54·5	16·0	0·9
1849	55·0	20·5	2·6
1850	48·0	20·0	1·6
1851	55·3	25·9	2·3
1852	53·0	23·0	3·5
1853	53·2	29·5	3·0
1854	55·2	—4·0	2·9
1855	53·7	21·6	0·5
1856	51·0	18·5	2·9
1857	53·5	17·5	3·2
1858	54·0	22·8	0·2
1859	54·5	27·0	0·6

The greatest heat in shade reached 56·0° in 1844, and only 46·5° in 1847, giving a range of 9·5° in greatest heat for December during the past seventeen years. In fourteen years the temperature reached 53°.

The greatest cold was as low as 4° below zero in 1854, and never below 29·5° in 1846, giving a range of 33·5° in greatest cold for January during the past eighteen years. The coldest years being 1842, 1843, 1845, 1848, 1854, 1856, and 1857; and the warmest, 1846, 1847, 1851, 1853, and 1859. In 1854 the temperature fell 16·5° below any other year.

Only 0·2 inch of rain fell in January, 1858, and as much as 3·5 inches in 1852, giving a range of three and a quarter inches for January, during the past seventeen years.

During this month the lowest temperature of the year is usually attained.

E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR JANUARY, 1860.

—o—

The sun is in the constellation Capricornus until the 20th, when he passes into Aquarius. He is at his nearest distance to the earth on the evening of the 2nd. He rises in London on the 1st at 8h. 8m., on the 15th at 8h. 2m., and on the 31st at 7h. 43m.; and sets on the 1st at 3h. 59m., on the 15th at 4h. 17m., and on the 31st at 4h. 44m.

The sun reaches the meridian on the 1st at 12h. 3m. 37s.; on the 15th at 12h. 9m. 32s., and on the 31st at 12h. 13m. 41s.

Equation of time on the 1st, 3m. 37s.; on the 15th, 9m. 32s.; and on the 31st, 13m. 41s.; the clock being before the sun, *i.e.*, the equation of time being addative.

Day breaks on the 4th at 6h. 3m., on the 12th at 6h. 2m., and on the 26th at 5h. 50m.; twilight ends on the 10th at 6h. 13m., and on the 27th at 6h. 37m. Length of night on the 17th, 15h. 39m.

Full moon on the 8th at 3h. 23m. p.m.

New moon on the 22nd at 12h. 17m. a.m.

The moon is at her nearest distance to the earth on the 10th, and most distantly removed on the 25th. She is near Jupiter on the 8th, and near Saturn on the 11th.

Mercury is not favourably situated for observation. He is a morning star, and situated in Ophiuchus at the beginning of the month, passing into Sagittarius, and into Capricornus on the 31st. He reaches his greatest western elongation on the 4th, and is farthest removed from the sun on the 26th. He rises on the 1st at 6h. 15m. a.m., and on the 31st at 7h. 20m. a.m.; and sets on the 1st at 2h. 35m. p.m., and on the 31st at 3h. 22m. p.m.

Venus is unfavourably situated for observation; she is in Capricornus in the beginning and in Aquarius at the end of the month. She is nearly circular, and rises on the 1st at 9h. 34m. a.m., and on the 31st at 8h. 53m. a.m.; and sets on the 1st at 5h. 54m. p.m., and on the 31st at 7h. 32m. p.m.

Mars is also unfavourably situated for observation. He is a morning star, in the constellation Libra, until the end of the month, when he passes into Scorpio. He rises on the 1st at 3h. 7m. a.m., and on the 31st at 2h. 53m. a.m., setting on the 1st at 0h. 47m. p.m., and on the 31st at 11h. 32m. a.m.

Jupiter is a magnificent object; he is in the constellation Gemini, and is in opposition and at his greatest brightness on the 11th. He rises on the 1st at 4h. 43m. p.m., and on the 31st at 2h. 25m. p.m.; and sets on the 1st at 8h. 59m. a.m., and on the 31st at 6h. 49m. a.m.

Saturn is also a fine object; situated in Leo, and is visible throughout the night, rising on the 1st at 7h. 50m. p.m., and on the 31st at 5h. 41m. p.m.; setting on the 1st at 10h. 31m. a.m., and on the 31st at 8h. 31m. a.m.

Uranus is in Taurus, a little above Hyades, and is visible throughout the night, rising on the 1st at 1h. 27m. p.m., and on the 31st at 11h. 27m. a.m.; and setting on the 1st at 5h. 31m. a.m., and on the 31st at 3h. 29m. a.m.

There is an eclipse of the sun on the 22nd, *invisible* in England. It occurs in the Great Southern Ocean, the central path crossing the South Pole, where it is *annular*.

Occultation of stars by the moon on the 5th:—No. 17, Tauri, 4th magnitude, disappearance 4h. 0m. a.m., reappearing in 34 minutes. On the 7th, ε Geminorum, 3½ magnitude, disappearance 11h. 48m. p.m. On the 9th, δ Cancri, 4th magnitude, disappearance 8h. 32m. p.m., reappearance 9h. 29m. p.m.

Eclipses of Jupiter's satellites at Greenwich:—On the 1st, at 7h. 39m. 10s. p.m., 4th moon disappears. On the 4th, at 7h. 34m. a.m., 1st moon disappears. On the 6th, at 2h. 2m. 54s. a.m., 1st moon disappears. On the 6th, at 8h. 54m. 33s. p.m., 3rd moon disappears. On the 7th, at 8h. 31m. 25s. p.m., 1st moon disappears. On the 8th, at 3h. 5m. 33s. a.m., 2nd moon disappears. On the 13th, at 6h. 11m. 3s. a.m., 1st moon reappears. On the 14th, at 4h. 10m. 28s. a.m., 3rd moon reappears. On the 15th, at 0h. 39m. 38s. a.m., 1st moon reappears. On the 16th, at 7h. 8m. 11s. p.m., 1st moon reappears. On the 18th, at 5h. 18m. 13s. p.m., 4th moon reappears. On the 18th, at 9h. 44m. 34s. p.m., 2nd moon reappears. On the 22nd, at 2h. 34m. 2s. a.m., 1st moon reappears. On the 23rd, at 9h. 2m. 37s. p.m., 1st moon reappears. On the 26th, at 0h. 21m. 13s. a.m., 2nd moon reappears. On the 29th, at 4h. 28m. 35s. a.m., 1st moon reappears. On the 30th, at 10h. 57m. 12s. a.m., 1st moon reappears.

Duration of twilight after sunset, on the 1st, 2h. 0m., and on the 16th, 2h. 1m.

The Pleiades are on the meridian on the 2nd, at 8h. 58m. 21s. p.m. Rigel on the 3rd, at 10h. 16m. 47s. p.m. α Persei on the 5th, at 8h. 15m. 46s. p.m. Aldebaran on the 7th, at 9h. 21m. 15s. p.m. Capella on the 19th, at 9h. 12m. 26s. p.m. Sirius on the 23rd, at 10h. 29m. 5s. p.m., and Rigel on the 26th, at 8h. 46m. 21s. p.m.

E. J. Lowe.

THINGS OF THE SEASON—JANUARY.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

—o—

Birds Arriving.—Occasional flights of Grosbeaks, Silktails, Norway Spinks, and Hen Chaffinches.

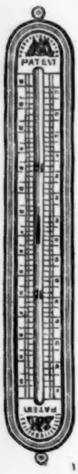
Birds Departing.—Snowflake, Orange-breasted and Gray Goosander, Long-tailed and Tufted Pocher, Grosbeak.

Insects.—Carabus catenulatus and cancellatus, Helobia brevicollis, Calathus cisteloides, 7-spotted and 2-spotted Coccinella, Acheta domestica, Cheimatobia vulgaris and rupicapraria, Peronea spadiceana. In ponds various Colymbetes, Dyticus, and Hydrous piceus.

Wild Plants.—Nailwort, Aconite fl., Poa trivialis, Winter Furze, White and Red Dead-nettle, Mosses and Lichens in fine condition.

Mr. Noteworthy's Corner.

THE ATMOSPHERIC CLOCK.—Mr. Noteworthy has been much amused by the performance of an atmospheric clock, which he regards as a valuable application to a purpose of utility of the simplest of all natural laws. This clock possesses no mechanism, but indicates the hour by the regular descent of a column of mercury, and might, therefore, with equal propriety, be called the gravitating clock. In the left-



hand cut the clock is represented in its complete form, with the mercury in the inner tube falling till it reaches the bottom. The clock has then to be reversed, and the mercury will traverse the tube again in the contrary direction, for all it has to do is to obey the law of gravitation. Mr. Noteworthy's young friends have asked him to explain the reason why the mercury falls so slowly and regularly as to serve for a time-divider, and he has made the right-hand diagram to explain the details. There are two glass tubes, one within the other. The inner tube contains the mercury, and also atmospheric air. At each end this inner tube communicates by a small orifice with the outer tube, and, consequently, the mercury, in its descent, has to force the air out of the inner tube to the outer, and thus its rate of descent is regulated. In the cut the arrows show the course of the inclosed air. The descending arrow in the inner tube is the air forced downwards by the weight of the mercury. This air escapes by the small orifice at the end of the tube, passes into the outer tube, and ascends in it, as shown by the two lowermost of the arrows. When it reaches the top of the outer tube, it enters the small end of the inner tube, and thus, as fast as the air is forced out below, it enters above, as shown by the descending arrow above the mercury. This clock is in no way influenced, or certainly not to any appreciable extent, by the external air, as the outer tube is hermetically sealed. The gravitation of the mercury and the resistance of the air in passing through the orifice determine the rate of motion, and the division of the scale of hours is, of course, in accordance with it. It is not only an instructive toy, but a really useful invention.

BIRDS IN WINTER—A QUERY.—Many of the finches, and other small birds that traverse the fields in "flights" during autumn and winter, are, as regards the sexes, separated into distinct bodies, one "flight" will consist of males only, and another of females. In the case of the robin, which never becomes gregarious, all the birds now seen near the habitations of man are males. What becomes of the females? Do they haunt deep woods and solitary places? And how is it that *all* the robins met with in gardens and orchards, and in other places near towns and villages, are males, and mostly birds of the same season?

EFFLORESCENCE.—Mr. Noteworthy does not believe all he hears, else he would tell of an old porcelain dinner-plate, which by a natural process has become covered with a forest of trees, shrubs, and flowers, while standing on a shelf in a common cupboard. Attracted by a handbill announcing the "startling fact," Mr. Noteworthy wended his way to No. 2, William Street, Shoreditch, and, on payment of sixpence, had a sight of the "Forest of Crystal Shrubs." It is simply a case of efflorescence, and the crystals, formed by some slow decomposition taking place in the clay, force themselves through the enamel, and, in some instances, rise to a height of half an inch in tufts and bundles. In several places portions of the enamel are lifted up by the crystalline growth, and appear like lozenges laid on the flat surface. It is the most curious example of efflorescence Mr. Noteworthy has yet seen, but evidently of the same nature as that which sometimes takes place on the face of a newly-built brick wall, when muriate or nitrate of lime oozes out in the form of a chalky powder. This dinner-plate has turned an honest tradesman into a showman, and it would perhaps have been better for him had Dame Nature left his cupboard alone.

CELTS IN THE DRIFT.—Mr. Edwards, an ingenious glass-maker of Birmingham, suggests, in the columns of the *Times*, that the so-called celts may be natural productions. He says, when glass cools too quickly, fragments fly off from the bulk of a shape and size closely resembling celts, and if masses of flint were at one time heated by subterranean fires, and then cast forth into the air, the rapid cooling of their outer surfaces would cause them to fracture, and so form natural resemblances to works of art. Mr. Noteworthy believes the celts to be celts, nevertheless; *that* is not an open question.

THE COMMON HOUSE-SPIDER.

(*Tegenaria domestica.*)

"What can there be interesting in that commonplace, repulsive, little creature, which infests our houses, annoys us by its presence, and shocks our sense of decency with its

Fig. 1.—The Female House-Spider (*Tegenaria domestica*), as seen with a Stanhope lens. *a a*, eyes; *b b*, mandibles; *c c*, maxillary palpi.

filthy webs?—in that cruel little monster, whose whole life is employed in weaving snares to entrap unwary flies, lying in wait for them in dark, damp corners of crevices, murdering them remorselessly when they are caught in its toils, and then sucking their life's-blood? The house-spider, indeed! Why, we sweep it from the very face of Nature wherever we find it, together with its chamber of horrors; and it must indeed be some strong temptation that would induce one to defile one's hands by contact with a creature the very idea of which suffices to inspire terror and disgust."

Thanks, reader, for your concise preface, and for such an accurate popular estimate of one of the most wonderful of God's creatures, formed for the attainment of wise and useful ends, and perfectly adapted to the office it is destined to fulfil. Endeavour to overcome your repugnance for a while, and let us introduce you to this little creature that inspires you with such disagreeable sensations; accompany us, first, in a brief examination of its remarkable structure, and then you may, if you think proper, continue your reflections undisturbed by any of our observations.

But you may, perhaps, not possess a Stanhope lens; we must therefore provide you with one, as well as with the living object to be considered. And see! here we are already face to face with our terrible spider! (Fig. 1.) You see it can return your wondering gaze fourfold, for it possesses eight eyes (Fig. 1, *a a*); simple indeed in their structure, and incapable of motion, but disposed in two rows on the top of its head, and so directed and arranged that they enable the creature to espy its prey from whatever quarter it may approach the web (Fig. 2). And

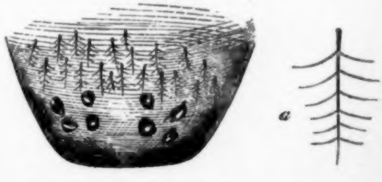


Fig. 2.—Enlarged View of Anterior Portion of Cephalothorax, bearing the eight eyes, and hairs. *a*, one of the hairs magnified.

woe to the poor victim when once ensnared in the toils; for the terrible spider immediately rushes on its prey, and brings such an array of weapons to bear against its unprotected body, as to render escape next to impossible. There is, perhaps, not another living creature so fearfully armed as the

spider. Below the eyes (Fig. 1, *b b*), you will perceive the large basal joints of the jaws, or mandibles, as they are technically denominated, wherewith it butchers its prey. And what terrible instruments of slaughter are these! Picture to yourself a pair of huge clasp-knives, with extremely broad handles (Fig. 5, *a*), the blades being so opposed to one another, that when they are forcibly driven into an object their pointed extremities encounter each other in the centre. Then conceive these knives to have the edges of their blades serrated with a row of fine teeth, commencing near the haft (Fig. 3, *a*); and on the handle itself (Fig. 3, *b*) five large pointed teeth, shaped like the head of a lance, and upon which the saw-like blade can be

FIG. 3.—Termination of the Jaw, or Mandible. *a*, row of teeth on the claw; *b*, basal joint of mandible, showing the five large teeth; *c*, commencement of poison-sac; *d*, course of the poison-duct. The last two are only visible when the mandible has been carefully bleached with chlorine.

brought to work to and fro. Lastly, you must imagine these terrible instruments to be poisoned, for within what we have called the handles of these knives (the basal joints of the mandibles) there is a receptacle (Fig. 3, *c*,) containing a subtle venom, which is conducted through a tube (Fig. 3, *d*) to the pointed extremity of the blade. The moment this pierces the body of the prey the poison is emitted, and entering the wound renders it fatal, probably at the same time benumbing the sensibility of the victim.

Did ever hired assassin of romance invent or employ a more fatal and diabolical weapon than this combination of poisoned dirks and saws? And yet this is but one portion of the

FIG. 4.—Edge of Maxilla, greatly enlarged, showing teeth and hairs.

spider's apparatus for despatching its prey; for, besides these mandibles, it possesses a smaller pair of jaws (the "maxillæ"), whose finely-toothed edges are comparable to a couple of deep rasps (Fig. 4), that most probably operate one against the other in a similar manner to the two limbs of the large jaws, serving to enlarge the wound from which the little monster sucks the life's-blood of the wretched fly!

But now let us turn our little spider upon its back, and, regardless of its puny struggles, investigate the under surface of its body. We shall then have an opportunity of seeing how admirably its eight long slender legs—(for you are, doubtless, aware that the *Arachnidæ*, or spider tribes, are furnished with

that number, in contradistinction to the insect races, which possess only six)—how admirably, we say, its eight legs are disposed, for the purpose of enabling it to grasp the poor fly in its terrible embrace. These legs, which have seven joints, or articulations, are, as you perceive (Fig. 5, *b*), placed in an oval upon the

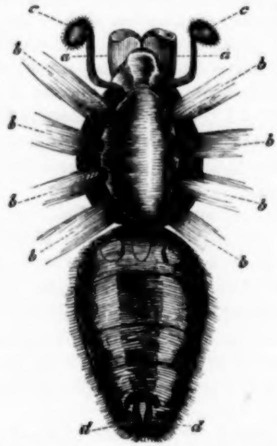


FIG. 5.—View of Under Surface of *Male* Spider, with the first joints of the legs. *a a*, mandibles; *b b*, legs; *c c*, maxillary palpi; *d d*, spinnarets.

under side of what is termed the cephalothorax,* and the object of their being of such great length and tenuity is not only that they may grasp the victim more firmly than if they were shorter, but also that, when stretched out (as we see them whilst the creature is at rest watching for prey), they may cause the weight of the body to be distributed over a large surface of the fragile web.

Nor are these members of locomotion wanting in features of interest, for they are all furnished at their extremities with a beautiful apparatus resembling a comb, terminated by a pointed hook (Fig. 6). These instruments are precisely of the most suitable construction to enable their possessor to grasp, card, disentangle, or wind its threads with the utmost facility, and if you were to examine them with a microscope, and compare them with the mechanical contrivances employed in our factories for a similar purpose, you would be compelled to

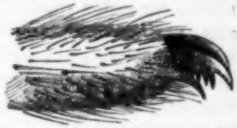


FIG. 6.—Terminal Point of the Spider's Foot, showing the hooked comb.

FIG. 7.—One of the Combs, highly magnified.

admit, perfect as you may consider the latter, that they are but awkward imitations of the efficient tools formed by the hand of the great Artificer (Fig. 7).

And now, if you will for an instant compare Figs. 1 and 5, you will notice on either side of the head, what might be mistaken for a fifth pair of legs, of shorter dimensions than the rest. These are the maxillary palpi, which probably correspond to the feelers of insects in their functions (although some naturalists believe the large mandibles already described to be metamorphosed feelers, or antennæ, as they are technically called), and you will perhaps be surprised to notice a difference in shape between these members in the two illustrations (Figs. 1, *c c*, and 5, *c c*). This is owing to the fact that the one represents the female and the other the male. The club-shaped palpi of the male (Figs. 5, *c c*, and 8) are said to serve a most remarkable end in connection with the gene-

* The "head-chest." The body of the Arachnidæ is divided into two sections, the cephalothorax (or head and chest fused together) and abdomen. In the insect races these three sections are distinct, and united by slender filaments.

rative process; but a consideration of this portion of the subject would be too great a trespass upon the domains of physiological science for such a popular article as the present, and we must, therefore, confine ourselves to pointing out the circumstance that the form of the palpi presents a distinction whereby the sex of the spider may at once be recognized, those of the male being, as just observed, club-shaped, furnished with several hooks, and a species of cup (Fig. 8), whilst those of the female taper to a point (Fig. 1, *c*), and are armed at the extremity with a toothed comb, resembling those at the end of the feet, as well as with several long sword-shaped hairs (Fig. 9).

Fig. 8.—Last Joint of one of the maxillary palpi of male spider.

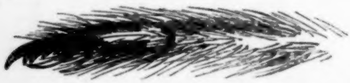


Fig. 9.—The Same in the Female.

Having frequently had occasion to refer to the web employed by the spider to entrap its prey, we must now mention that the most noteworthy feature in the structure of the animal, is the contrivance whereby it is enabled to construct this web. If you move your lens to the termination of the abdominal segment of the body (Fig. 5, *d*), you will perceive two little protuberances, in which you cannot fail to recognize the spinnarets. This is the longest and most prominent of three pairs (Fig. 10)—the remaining two presenting the appearance of circlets (Fig. 10, *a*)—with which the spider is endowed for the object referred to, and they are all studded over with rows of little microscopic tubes (Fig. 10, *b b b*), from which there exudes a glutinous substance that solidifies into a filament as soon as it becomes exposed to the atmosphere.

It is the combination of all these microscopic filaments that forms the silken thread with which the wily assassin weaves its toils, for the microscope has revealed that every one of those almost invisible fibres which we see floating in the air, is composed of hundreds of finer ones, just as a ship's cable is formed by the union of numerous lengths of hempen yarn.

But mark the difference in the two operations! In the fabrication of a rope, the twisting process is supplementary to much human labour employed in the cultivation of the hemp, its preparation for spinning, and its

Fig. 10.—Posterior Portion of Spider's Body, showing the six spinnarets. *a*, Shorter spinnarets, with circlets of tubes; *a**, the same magnified; *b b b*, spinning tubes on long spinnarets; *b**, single tube magnified.

manufacture into yarn; whereas, our wonderful little spider produces from certain glands within its body the substance of which the invisible silken yarn is constituted, and forms it into a cord much more rapidly than the eye can follow the process.

Is not this an admirable example of the superiority and simplicity of Nature's operations, as compared with the industrial processes of the human race?

With wonderful rapidity and instinct the spider employs these threads to weave its web, or wanders from place to place, often constructing a perfect net, to entrap its prey (upon accurate geometrical principles*), in less than an hour, and, what is most remarkable of all, performing this task in what to us would be total darkness!

There are many other curious and mysterious circumstances connected with these webs. The garden-spider (*Epeira diadema*), for instance, covers all the concentric filaments of its net, at regular intervals, with glutinous or adhesive globules, presenting under the microscope the appearance of pearls strung upon a thread, and destined to facilitate the capture of its prey. But our restricted space will not allow us to dwell upon these interesting details, and for all that concerns the habits of the spider, as well as its internal physiology, which is as interesting as its external structure, we must refer you to some of the books that have been published on the subject;† or, if you wish to render yourself useful to science, we recommend you to open the book of Nature itself, and there to study the life-history of a creature whose habits have unfortunately prevented it from receiving its due share of the naturalist's attention.

It is certainly an annoyance to us in our houses, *and warns us of the necessity for cleanliness;* but were it not for the presence of the spider, the flies and other insects with which our dwellings swarm in summer, would be intolerable, and it is therefore a wise provision of Nature to reduce the number of these prolific insects. A little reflection, too, will show you that its life-history and habits present only a repetition of those of most other animals of prey, of which many, although possessing no such features of interest as our little spinner, are regarded with much less horror and repugnance.

Nay, if we are to believe what one of our poets tells us, the little arachnidan is not half so cruel and predatory as man himself. He says:—

> "Ingenious insect, but of ruthless mould,
> Whose savage craft as nature taught, designs
> A mazy web of death—the filmy lines
> That form thy circling labyrinth, enfold
> Each thoughtless fly that wanders near thy hold,
> Sad victim of thy guile; nor aught avail
> His silken wings, nor coat of glossy mail,
> Nor varying lines of azure, jet, or gold:
> Yet though thus ill the fluttering captive fares,
> Whom heedless of the fraud thy toils trepan;
> Thy tyrant fang that slays the stranger, spares
> The bloody brothers of thy cruel clan;
> While *man* against his fellows spreads his snares,
> Then most delighted when his prey is *man*."

Very poetical, indeed! and unfortunately too true, so far as the human race is concerned, but not so with regard to the spider, for it is one of those few creatures whose ferocious disposition prompts them to prey upon their own species; nay, even the gentle ties of marital affection do not serve to restrain its thirst for blood, and it is not at all an unusual circumstance (and one that we have ourselves frequently witnessed), for the female to destroy her mate.

But if there have been minds that have dwelt upon such terrible and repulsive features as these, in the history of the arachnidan species, there are also others in whom the theme has been productive of those gentle and sublime thoughts that suggest themselves sooner or later to every right-thinking man

* This refers more particularly to the garden-spider (*Epeira diadema*).

† Kirby and Spence's "Entomology," concerning the habits; Carpenter, or Newport, and Vogt and Treviranus (German) as regards Anatomy, etc.

who directs his reverent attention to God's glorious works; and we shall now conclude these few observations on the humble house-spider, by quoting the lines of one* whom the consideration of its habits inspired with a sentiment of religious awe and veneration:—

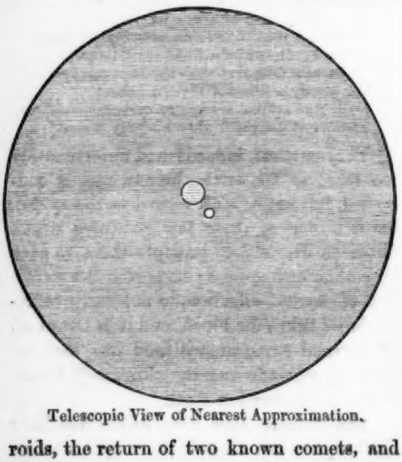
"See how threads with threads entwine;
If the evening wind alone
Breathe upon it, all is gone.
Thus within the darkest place
Creative wisdom thou may'st trace;
Feeble though the insect be,
Still He speaks through that to thee.

"As within the moonbeam I,
God in glory sits on high,
Sits where countless planets roll,
And from thence controls the whole.
There, with threads of thousand dyes,
Life's bewildering web he plies,
And the Hand that holds them all
Let's not even the feeblest fall."

Liverpool. JAMES SAMUELSON.

THE CONJUNCTION OF THE PLANETS JUPITER AND VENUS, ON THE MORNING OF JULY 21st, 1859.

THE year 1859 was, on the whole, poor in astronomical occurrences. In this respect it offered a strong contrast to its immediate predecessor; for, in 1858, astronomers were gratified by the discovery of four new aste-



Telescopic View of Nearest Approximation.

roids, the return of two known comets, and the unexpected appearance of four unknown, one of which was the ever memorable "Donati," as well as by the occurrence of a lunar and solar eclipse, visible from this country. In 1860, whatever chance visitors may come, we have again a lunar and solar eclipse to expect, both visible from England, and the latter total in Spain and Africa. But last year (1859) only one comet and one asteroid rewarded the explorers of the heavens; and though four solar eclipses occurred, none were total, and all were invisible in England, being displayed only to that select assemblage of observers likely to view them in the far Southern Ocean, or from Siberia, the northern part of North America, and Greenland; and the two lunar eclipses were announced to be visible from Australia and Asia.

The occultation of Saturn by the Moon, on May 8th, was the occurrence most nearly resembling an eclipse, visible from this country, and carefully it was observed when the day came. But there was one more phenomenon to be seen in the year 1859, and that one of rare occurrence, namely, the unusually near approach (in apparent position) of the planets Jupiter and Venus, at about a quarter to four o'clock, on the morning of July 21st. This was foretold in the "Nautical Almanac" of the year, in the following not very exciting terms:—

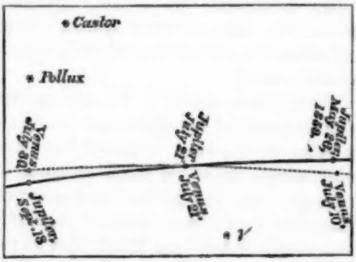
"JULY 20, $14^h\ 45^m$ ♀ ☌ ♃ .... ♀ $0^\circ\ 1'$S."

The attractive "Illustrated London Alma-

* Oehlenschlager.

nac," however, gave a more lengthened account of the promised phenomenon, illustrated by a woodcut sure to catch the eye, though the reader could at first hardly believe it was intended to represent an expected appearance, so singularly near were the planets placed to each other.

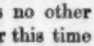
A few words may here be added with advantage on the subject of planetary conjunctions. The planets—that is, the principal planets, not including the asteroids—run in tracks very similar to each other, as viewed from the earth; but as they all appear to travel with very different degrees of speed, they frequently overtake each other. The annexed illustration is intended to show how



Portions of the Orbits of Jupiter and Venus.

the path of Jupiter runs part of its way north of that of Venus, and part of its way south; also how Venus, from moving actually quicker than Jupiter, and also from its being much nearer than Jupiter to us who view it, will traverse a portion of the celestial vault in twenty days, which will occupy Jupiter nearly four months. Whenever it overtakes Jupiter a "conjunction" occurs; but the curious thing in the present instance was, that it outran Jupiter this time, so close to the point where its orbit crosses that of Jupiter, that the two planets appeared to the naked eye as one star. Such an occurrence was already on record; for Kepler states that, on the 9th of January, 1591, he and Mœstlin witnessed an occultation of Jupiter by Mars, and that the red colour of the latter on that occasion clearly indicated that Jupiter was the further of the two planets. He also mentions that, on the 3rd of October, 1590, Mœstlin witnessed an occultation of Mars by Venus. On this subject, however, Professor Grant remarks—"It is to be borne in mind that these observations were made before the invention of the telescope, so that it is doubtful whether, in either of these cases, the one planet was actually superposed above the other." He adds that phenomena of a similar nature have occurred in more recent times. They are, however, extremely unusual, and this conjunction was alluded to early in the year by Professor Wolfers, of Berlin, as a "rare phenomenon."

The writer was fortunate enough to see it under circumstances more favourable than those enjoyed by the illustrious Kepler, having been one of a party of nine persons who assembled in the chilly morning twilight of July 21st, shortly after three o'clock a.m., for the purpose of viewing the conjunction through an old three-inch Dollond telescope.

The upper part of the sky was pretty clear, and though the rapidly-increasing daylight allowed but few stars to be seen, the moon was bright; but the whole eastern horizon, to the height of several degrees was obscured by a reddish fog, shaded off into indistinct filmy clouds. At first sight, we despaired of seeing anything; but while we looked, *one small star* shone out in an interstice between the clouds. It was no other than our much desired planets, for this time appearing as a double star of unusual composition. The astronomical eye-pieces of the old telescope had been for some reason discarded by us, in an observation of the moon on the preceding evening, and the terrestrial eye-piece was now employed. The planets were still half concealed by fog. Venus appeared through the telescope of a deep yellow colour, Jupiter a dull grayish white, and at about this distance from each other: 
Sunrise rapidly approached; Venus

became paler, and Jupiter more and more indistinct from its gray colour, though its outline was defined with some sharpness. The planets, as long as visible, neared each other, and, though occasionally concealed by clouds, had risen to a somewhat clearer atmosphere as they gained their nearest position, represented in the first illustration. Almost immediately afterwards, a larger drift than usual closed the observation by completely concealing the planets. But the sight remained vividly impressed on the mind's eye, with that peculiar clearness which seems to belong to the remembrance of celestial objects; and the writer is glad to give that remembrance a tangible form, by transferring a record of it to the pages of RECREATIVE SCIENCE.

MARY WARD.

Trimleston House, near Dublin.

NOTES ON THE ELAND.

THE permanent addition to our meadows of an entirely new and distinct species of cattle, furnishing a wholesome meat of a novel kind to our tables, to vary the eternal round of beef, mutton, and pork, is an event of very general interest. Even as regards its influence upon

the aspects of the landscape scenery of our agricultural homesteads, there is much interest in the novel feature, as producing a new series of impressions of beauty, and presenting fresh objects which will be eventually blended by a rising race of artists with the home associations of older standing; for groups of Elands will at no very distan epoch often form ordinary features in the ever-attractive pictures furnished by our rich meadow scenery.

The addition, however, of a new and very delicious meat, of succulent and wholesome character, to the very restricted list of our larder stores, is of far more material importance. It is well known that too much sameness of food is not conducive to health. For instance, it has been found upon experi ment that troops fed upon the very finest mutton continuously, even when varied by every culinary device to procure variety of flavour, have soon lost their usual health; which has been restored on recurring to the ordinary alternating series of mutton, beef, and pork. It is certain that if fish food were made to alternate more frequently with our more solid meats, that beneficial effects would result; for it has been observed by medical practitioners, in Catholic countries, that where on one day in the week fish alone is eaten, those disorders immediately arising from indigestion are far less frequent than with us. In many inland and remotely situated localities it is, however, very inconvenient to procure fish, even in these days of railways, and therefore the occurrence of some other means of varying our routine of

ordinary food is to be all the more thankfully accepted. Being, too, of that lighter kind of meat which comes under the head of "game," which is found to be of easier digestion than the flesh of sheep or oxen, the new meat is the more acceptable. It resembles venison in many of its characteristics, but is more succulent, and possesses a flavour of its own which many will greatly prefer.

The Elands, from which we are now led to expect an abundant supply of this new meat, are natives of South Africa. They are the largest of the antelope tribe, to which they belong, and appear therefore better suited than any of their congeners for the purposes of forming a domestic breed, furnishing a new kind of meat; though, since their first introduction with that view, Dr. Livingstone has described many other species of the antelope tribe, which are likely to be imported with a view to acclimation for similar purposes at future periods. Several very interesting experiments in the acclimation of exotic animals, likely to prove of value for domestic uses, are at the present time being made in Paris, where a company was recently formed (the Société Imperiale d'Acclimation) for that express purpose. It was as manager of that company, in so far as regarded the scientific arrangements for rendering the change from tropical regions less trying to animals accustomed to a temperature averaging above a third higher than that of Europe, that Mr. David Mitchell, the energetic and talented secretary of the Zoological Gardens, had been requested to take up his abode at Neuilly for a time; and it was while there that the singular and mysterious accident occurred which caused his premature and lamented death.

It is to be regretted that we have no establishment of the kind in England, to which the talents of Mr. Mitchell might have been devoted at home. The only approach to such an undertaking was that established by the late Earl of Derby at Knowsley, occupying above a hundred acres, where, among a magnificent collection of animals, the first Elands ever brought alive to this country were comfortably located in November, 1842. This small herd consisted of two male Elands and a female. A fresh supply arrived at Knowsley in 1852, but the noble owner was not destined to witness the success of this last importation. He died soon after their arrival, bequeathing them to the Zoological Society in the Regent's Park, where, under the able management of Mr. Mitchell, the original herd of five increased so rapidly as to render their dispersion necessary. Several pairs were sold; and they have since increased and multiplied in a satisfactory manner, in open parks and meadows, so that their acclimation may be said to be complete.

On their first introduction, it was said that even in their wild state they had so great an aptitude to fatten, that a full-grown bull in good condition was often found to weigh 2000lbs. If this statement could be realized, they would be in this respect very little inferior to our own celebrated short-horns; but experience has not as yet fully borne out this statement. This may be owing to the inferior nutritive powers of our grasses to those they feed on in their native wilds; and if so, the introduction of some of the coarse African grasses as pasture for these animals, will, perhaps, enable the breeders of herds of Elands to realize in weight and condition surpassing even that which was at first expected. It was stated also, in the first enthusiasm of the novelty, that the attainment of their full growth was extremely rapid. This also has been found a somewhat delusive hope, inasmuch as it is now affirmed that from six to seven years is the earliest period at which the animal, as at present acclimated, yields what may be termed good "butcher's meat," being nearly double the age at which mutton of the highest quality becomes fully mature; and almost the same may be said of most of the finest beef, which is certainly produced at a much earlier age of the animal,

than that at which the Eland vension seems likely to be obtained.

This drawback, though considered a very serious one by experienced breeders of cattle, is in some degree compensated for by the fact that the animal acquires "condition" much more naturally, and without the excessively rich stimulants used in the stall-feeding, by which our finest beef is prepared for the market. The gain in this respect may more than compensate for the comparative slowness at which maturity is acquired in our climate. At all events, the herds are increasing in number, and also in the somewhat more rapid progress to full development; and there appears no doubt but that at no distant period a regular supply of the delicious meat which they furnish will be found in our markets; though, perhaps, at first, the price may be somewhat above that of other meat.

The first Eland bred in England for the table was killed on the 7th of January, 1859, at Hawkestone Park, the seat of Lord Hill, and the result was, after all drawbacks, sufficiently favourable to prove the entire success of the experiment, and the certainty that it will not be abandoned. The animal killed, though not more than six years old, weighed 1176 lbs., and with much less proportion of bone than in the best-bred "short-horn," while the texture of the lean was found to be as fine and as richly flavoured, and the fat firm and delicate. In all the joints great juiciness was remarked, and, in addition to its value as *meat*, it appears to display wonderful qualities for the formation of a remarkably rich soup.

On another occasion I may give some account of other kinds of foreign deer that are in progress of acclimation in this country, some of which promise to equal, if not surpass, the Eland, as furnishing additional and highly desirable food for the table.

The engraving is after a photograph taken in the Zoological Gardens, Regent's Park.

H. Noel Humphreys.

THE BALANCE OF LIFE AND DEATH—A TEACHING OF THE AQUARIUM.

In the vast procession of beings which passes before the eyes of God as a panorama, and of which man catches but imperfect glimpses here and there, the many which drop out of the ranks into the jaws of death form the tesselated pavement on which the successive races tread, secure in their perpetuity. Life stands in fear of death, though death is but its servant—a faithful servant—appointed by the Author of life to gather life's tangled threads into an order of successive developments. The dying Christian may fear death, though assured of immortality; and the unthinking worm writhes in its expiring agonies, as if it would by a last effort struggle into strength once more. Deeply hid in the core of the organic universe is the secret of Death, "who keeps the keys of all the creeds;" yet man is permitted to read a part of the mystery in the experiences of his kind, and in the records of past ages. He doubts the fact of death, while openly admitting it; for his fear dictates a thought directly opposed to reason, to observation, and to the knowledge that has been revealed—

> "He thinks he was not born to die,
> And Thou hast made him, Thou art just."

Yet when man looks upon Nature, he sees everywhere the records of death's work among the representatives of creative energy. The stratified rocks are but the tombstones in the great graveyard of the world; they cover the bones of a million generations, and their inscription is, "The dust we tread upon was once alive." If the infusion of life into

countless forms, each in itself perfect, needed nothing less than Almighty power, it needed Almighty power too to complete the scheme in the institution of dissolution; and the grim king of terrors, before whom the bee and the sparrow tremble, perhaps, not less than man, became co-worker with God by a wise and beneficent appointment: and so the orders of being began, and have to this hour continued, as a series of dissolving views, in which there is no hiatus, but only *change;* no shifting of the focus or the screen, no aberration or intermission of the source of light, but an unending variety in the pictures. We know not how other worlds may fare, but this we know, that *here* death supplies from every extinguished picture the colours with which the next are painted, and we live—man and brute—on the debris of the past.

I see all this and more in the aquarium; it teaches me lessons in physics, and, I trust, also teaches me that the moral and spiritual truths of the universe may be illustrated, sometimes explained, by a patient study of the commonest things. The aquarium is a world in little; it sustains itself. For the moment, I put aside the law of gravity as a universal law, and the presence of the atmosphere as a universal thing, and I call it a world, needing no aid for its continuance and the perfect adjustment of its balance of power from external things. I take a vessel of glass, a few pebbles, a few pieces of sandstone rock, and a sufficiency of water, and to that I commit my fishes and insects, and say, "There is your world; the order of nature is such, that you may henceforth live and die without human interference." I say nothing here of the details of management; I am looking for instruction in the laws of life and death.

The two requisites of animal life, food and air, must be generated in this world, or it ceases to instruct me; yet the water contains but little of each, and whence is its supply to come? God has ordained such a wealth of organic forms, that wherever the conditions of life are found, life takes possession of the spot, whether it be the bottom of the ocean, the dripping roof of a cave, the expanse of the viewless air, or the mimic lake I call an aquarium. Forthwith the dead stones become alive with greenness, the glass walls assume the semblance of a meadow, the milky hue of the water disappears as the earthy particles it held in solution subside, and the light that streams through it takes a tint of greenness. There is an order of vegetation appointed to occupy such sites, and almost every non-metallic, and some metallic substances too, become speedily coated with confervæ, when their surfaces are kept moist a sufficient length of time. Were it not so, the inhabitants of my world must perish; and to prove the fact I try an experiment. I place some fishes in a clean vessel of water, without pebbles and without rock; the moment the first dim bronzy speck appears, I rub it off the glass, and so thwart the course of Nature. The fishes soon exhaust the water of its oxygen, and though the water attempts to renew its supplies by absorption from the atmosphere, the compensation is too slow, the fishes come gasping to the surface, and in a short while perish.

Even then I learn something from their death if I leave the vessel in the hands of Nature. Death has no sooner spread his black banner over my household gods than life of another kind arises to confound him, and the microscope reveals to me myriads of animals and plants, and organisms that seemingly occupy an intermediate place between the two great kingdoms, rioting upon the wreck that death has made. My half-dozen dead fishes have given birth to existences numerous as the stars in heaven, or as the sand upon the sea-shore, innumerable. While these devour the banquet death has spread for them, while forests of confervoid threads rise in silken tufts like microscopic savannahs, Nature is passing portions of the ichthyic

debris through her laboratory, and the very source of life for which they pined and perished—oxygen—is poured in in large measure, and the corruption is quickly changed to sweetness. Of the once sportive fishes some portions have become air, other portions have become water, but the chief of their bulk lives already in the vegetation which hides their grave, and the moving throng with which that vegetation is peopled. God's purpose in the working of the laws in obedience to which these changes have taken place, is manifestly to keep ever true that balance of life and death of which He holds the beam in His own hands.

But my aquarium which has not thus been interfered with, presents already a similar scene of life and bustle. When first supplied, the milky-looking water was abundantly full of gaseous matters, and every part of the rough rockwork was, for a time, studded with silvery globules. The fishes consumed all that in the process of breathing. As the water passed through their gills the oxygen was absorbed; that oxygen, by a process of refined chemistry, and perhaps by the help of iron also, gave their gills a bright red colour, gave their blood its red colour too, and by other processes not less refined, sustained the balance of life's functions within them, for without it they must perish. We believe that not the airiest particle of earth, atmosphere, or water, nor the most minute globule of condensed moisture, or the most infinitesimal point of meteoric dust, can ever be lost, at least during Time, from the fabric of the universe. My fishes tell me that the oxygen they absorb from the water, they again return to it, but *in another form*. They *in*spire oxygen and *ex*pire carbonic acid, just as a man does, and every other living creature that moveth upon the face of all the earth. Is it within the reach of human power, even when reason, imagination, and fancy combine together as a bold triad to look direct upon a fact, to appreciate that principle of terrestrial life by which animal and vegetable organisms reciprocally labour to maintain the balance of atmospheric purity? The carbonic acid given off by the animal is poison to it, if it accumulate while the supply of oxygen is cut short. It was carbonic acid as much as absence of oxygen that killed our fishes just now, for though inhabitants of water they were not the less suffocated. Therefore I see *why*, in the tank that has been left alone, plants have cast anchor on the glass walls, the brown pebbles, and the gray blocks of sandstone rock. My fishes breathe and breathe. If their numbers are properly proportioned to the area they occupy, they will never exhaust the water of oxygen, never render it fœtid with carbonic acid, so long as one necessity of vegetable life—light—is allowed to use its active influence to paint the plants green, even as oxygen gives a sanguine hue to the gills or lungs of the fishes. To those plants the carbonic acid which the fishes expire day and night, is as essential as oxygen is to the animal economy, and thus, without introducing a single scrap of any living plant, the balance is sustained, and death seems to be kept at a distance. If at first I threw in a tuft of callitriche or anacharis, or any other true aquatic vegetable, oxygen would be supplied abundantly; and in practice it might be well to begin so, because some little time elapses ere the seeds of the microscopic forest, the tops of whose trees present to the eye but a felt-like coating of superficial greenness, are developed into true plants; though with a fair amount of indirect daylight, and at certain seasons of the year, a few hours suffice to set the vegetative process, with all its proper consequences, in full action. Many of the readers of this paper will call to mind the aquarium that stands in my entrance hall. It contains twenty fishes, large and small, and not a single scrap of vegetation except what has been developed *in situ* by spontaneous generation. It is three years since that was fitted and stocked,

and committed to the management of Nature, with the sole exception of the external aid afforded by regular supplies of food for its inmates, which need not be taken account of, now that we are considering it as a world in which the balance of life and death is sustained by the operation of principles ordained by the Creator.

It is when we leave the principles and attempt to classify the details of the scheme that we become bewildered. The smooth revolution of the flywheel and the noiseless oscillation of the piston, convince the unprofessional observer of a great engine, that mechanical motions are possessed of poetry; but if he would analyze the relations of the cog-wheels, the indications of the "governor," the "guage," and the pressure-valve, he must descend to hard facts, and forget for a while the sublime suggestions of a system of mechanism that throbs like a living creature. Admit a full glare of summer sun to the aquarium, and forthwith the water loses its pellucid fluidity, and becomes deeply tinged throughout of a dull green, as if some pigment had been dissolved in it. Instead of plants attached to stones and glass only, and animals that float unseen, the whole of the water is occupied by visible masses of animal and vegetable life; and if the fishes suffer it will be from undue heat, not from the addition to the element in which they live of this new mass of being. Shut out the sunshine, let the fresh air play over the surface of the water, let moderate daylight stream through it as before, and speedily the green fog clears away, the water again becomes transparent, and the balance is restored. Monas, euglena, uvella, cryptomonas, gonium, and other wondrous infusoria, may be detected as constituents of the cloudy mass while it lasts, called into being because the conditions of the tank were such as they required, as if life in embryo was everywhere locked up until the moment came for its liberation, and some particular circumstance was the talisman to set it free; or if we consider created forms to be marshalled in grand procession, may we not expect that every tribe will hurry to its appointed place the instant that a door is opened?

Microscopists have long been at war, but without bloodshed, as to the place to be assigned to certain organic forms which are hidden from our common eyesight. While the war goes on as to whether desmidiaceæ and diatomaceæ be animal or vegetable, or both, let facts suffice us here in the study of the aquarium. Does an animal exhale carbonic acid? Yes. Well, here are plants or animals, concerned in keeping up the balance, which exhale oxygen, and their name is legion. Volvox globator and the bacillariæ labour as hard to supply the fishes with the life-sustaining gas as do the silken threads of verdure that line the glass like a carpet. Is the possession of starch a distinctive feature of the vegetable? Perhaps so. Truly here are desmidiaceæ that contain starch, and if I make the possession of cilia the test for assigning certain forms to the animal kingdom, I find in the aquarium spores of algæ furnished with them. Motion I know to be no test, because algæ spores dance through the water gaily till they find a resting-place, and when the aquarium was first filled, it was by dancing they at last found where to pitch their tents, and cease their nomad wanderings. But they all work together to sustain the balance, and the law of "give and take" prevails amongst them—the stentor devours the oscillatoriæ, rotatoria, and monads, and the hydras swallow all; every darting speck is a tomb wherein some smaller speck of life is to be buried, and life thus prospers on the decay it is itself undergoing.

But all this while a fine deposit slowly settles among the pebbles, which form the lower stratum of this watery world. Between the stones a fine alluvial silt collects

and thickens. The first frost, sufficiently severe to touch the tank, causes the whole green coating to peel off from the glass and rock, and while this subsides, to add to the thickness of the alluvium—how slightly, and yet how sufficiently for an example of Nature's working!—a new growth commences, and *that* balance is restored. Do you not see that the chief teaching of geology—the piling of stratum upon stratum, the conversion of disrupted rock and decayed plant and animal into rock again—is here exemplified in the history of a domestic toy, which contains already one example of stratification in the silence of watery submergence? A tank which has been fitted with loam, pebbles, and plants of the brook and river, will, if left undisturbed for three years, be in this state. Those plants will all have decayed, but there will be an abundant spontaneous vegetation. The accumulations of that short period will have settled into a close mass, almost as hard as stone; and if fishes have died in the meantime, and have not been removed, their bones will be found overlaid with hardened mud, just as we find them in the old red sandstone, or the chalk, or the carboniferous rocks, and shall we not call them *our own* fossils? See again in this case in which death has been very busy (for plants of large growth soon perish in the absence of sunshine, and occasional attendant accidents will carry off some of the finny pets), how life has been equally active on the other side, for such an aquarium will be a hundred times richer in those spontaneous growths we have already spoken of, and visible forms of infusoria and true zoophytes will abound, and every class will be more fully represented, down even to the twilight monad.

Though this paper must have an end, there is no end to the teaching of the aquarium. It is a watery microcosm of living and dead wonders, and we need not marvel that the balance of life and death may be observed in its succession of changes, because all the physical forces of the universe are locked up within a single bead of dew, and all the functions of organic creation are comprised in the economy of a monas termo. If God so ordains that life shall be constantly soaring from the tomb, if the story of the Phœnix ceases to be a fable, need man, the victim of doubts and fears, ever fail in his trust of that blessed promise, that "this mortal shall put on immortality, and this corruptible shall put on incorruption." Science may fix his mind on the appreciation of God's wisdom and power as he reads the handwriting of the Almighty in Nature, but through faith in another revelation must we hope to exclaim, triumphantly, "O death, where is thy sting? O grave, where is thy victory?" Or to pass from divine to human consolations, we may take up the apostrophe of the great Raleigh, and say, "O eloquent, just, and mighty death! what none have dared, thou hast done; what none have attempted, thou hast accomplished; thou hast gathered all the might, majesty, and meanness of mankind, and hast covered them with these two words, "*hic jacet.*" Nature's children have a dread of death, but Nature herself is in friendly compact with the master of silence. If the *types* which are the ideas of God, have survived from the oldest rocks to this present hour, will not the spirit which lives on ideas, and evolves them as the aquarium evolves its throng of animalcules, live for ever? It is not hard to believe with Tennyson:—

> "That nothing walks with aimless feet,
> That not one life shall be destroyed,
> Or cast as rubbish to the void,
> When God hath made the pile complete."

"The pile" will be complete when God's purpose is fulfilled in man, to whom it is given to hope after eternal life, and with eyes of faith to pierce through the veil, and behold the wondrous things of eternity.

Shirley Hibberd.

THE ANECDOTE HISTORY OF PHOTOGRAPHY.

COLLECTION II.

Heliography.—To the discovery made by the persevering Niepce, he gave the name of Heliography, or sun-painting. He died soon after, in 1833.

Acknowledgment of the Discovery by the French Government.—In consideration of this interesting and remarkable discovery, the French Chamber of Deputies voted an annual pension of 6000 francs to Daguerre, and of 4000 francs to Isidore Niepce, son of the late photographer, as purchase-money for the secret of the Daguerreotype; and for "the honour of having presented the scientific and artistic world with one of the most surprising discoveries that adorns their country." "France," said Arago, on that occasion, "has adopted this discovery, and is proud to present it as a gift to the whole world."

The Talbotype.—In January, 1839, the Honourable Fox Talbot discovered and declared the method he had perfected for preparing paper used in the photographic process. One was to cover it with a thin layer of chloride of silver, made sensitive for placing in the camera by repeated washings. To fix the images, he placed the paper in a brine bath, or common salt (chloride of sodium), but at first it was found that the light parts turned bluish on being exposed to daylight. This difficulty was soon surmounted. Mr. Talbot called his process the Calotype, and he brought it to such perfection, that an image might be taken in the camera in less than a minute. Early in 1830, Mr. Talbot sent the result of his experiments, in the shape of photographs on paper, to the various scientific circles in London and Paris; and they were admitted to be a vast advance upon all previous accomplishments. As Mr. Talbot protected his process by patent, very little was done in the way of its public dissemination for years, until he generously gave it to the country as a free gift. Among the specimens so sent were copies of a Hebrew psalm, of a Persian gazette, and of an old Latin chart of 1279, all wonderfully true to the originals. There were also white porcelain vases, shells and tapers, and a stand with white hyacinths, together with a picture by Corregio, all in well-disposed light and shade.

Posture for Taking Portraits.—Some good rules for posture in taking portraits have been laid down by M. Schubert, painter, of Berlin. He suggests that the posture should be easy and unconstrained, the feet and hands neither projecting too much, nor drawn too far back; the eyes directed a little sideways above the camera, and fixed on some object there, but never (as is too frequently the case) on the apparatus, since this would tend to impart to the face a dolorous and dissatisfied look. Long arms and legs should be drawn back.

Attitude for Stout and Thin Persons.—Stout persons, says M. Schubert, should be placed at a certain distance from the apparatus, turning towards it a little sideways; while people of slender proportions should be made to sit full in front, and nearer the apparatus.

Position of the Hands.—The hands should rest easily on the lap, neither too high nor too low, or one hand should be placed on the table, the other holding a book, or some other object. A thick hand should show the thumb in the foreground, with the fingers bent a little inwards. A long hand had better show the back. A hand of handsome shape, neither too long, nor too short, should show full two-thirds, with the fingers easily and gracefully hanging down.

Full and other Faces.—A full round face, with large mouth, small eyes and nose, should be taken in half profile, so as to show one side of the face in full, with very little of the other side. A moderately full face, with aquiline nose and handsome mouth and eyes, should be taken in three-quarter profile. A countenance with strongly-marked features, full in front.

For Twin Portraits and Family Groups.—When two persons are to be portrayed together, one should lean lightly on the chair of the other, and the faces of both be turned partly to each other, as in conversation. Or they may be placed at a table opposite each other, in the same attitude of conversation. In arranging family groups, care should be taken to place the several persons constituting the group at the same focal distance.

Attitude and Dress of the Ladies.—In the case of taking the portraits of ladies, the addition of a shawl or boa, thrown lightly over the shoulders so as to hide defects (if any) and distribute light and shadow, are recommended as tending to produce a pleasant impression. Yellow and red in dress should be avoided, plain coloured dresses, neither too light nor too dark, furnishing the most pleasing pictures.

Portraits in their Natural Colours.—The desideratum of obtaining portraits and pictures in all their natural colours has long been sought for, as the one thing only wanting to give to photography that perfection to which other arts and processes have attained. Many experiments, but hitherto with unsuccessful results, have been made to fix and transfer to the photographic plate or paper, not alone the lineaments, but the latent colour of the eye, and of the complexion, and the dress. Mr. Hill, an American, is reported, however, to have discovered a process which developed certain phenomena, impressing him with the conviction that the thing was possible. Mr. Hill, who has given to his process the title of the "Hillotype," states that in the course of his experiments one colour, the "red," in the figure of a vestment, developed itself brightly. He found, further, that the vapour arising from metals, such as arsenic, cadmium, zinc, selenium, bismuth, potassium, and sodium, possessed the power of developing latent images with their lights and shades. The same result was obtained with different gases. On one occasion he obtained a perfect impression in colours, and in January, 1851, forty-five designs, with all the different colours in perfect gradations. Mr. Hill's process, however, has not been brought into practice, and hence it must be viewed as rather problematical or mythical as a matter of actual accomplishment.

The United States Senate and Mr. Hill's Discovery.—A report on Mr. Hill's process was presented to the senate of the United States by the Committee of Patents, who stated that they had had explained to them the history and principle of the invention, of which numerous specimens had been laid before them, and they were of opinion that the inventor had solved the problem of photographic colourations. Mr. Hill had arrived at this discovery, by which the works of Nature might be copied in their original hues, through three years of persevering toil, though the discovery had yet to be perfected in its practical details. They recommend that the maker be placed on the records of the senate, and consider the discovery as one of great prospective utility and importance as affecting portraits, landscapes, botany, morbid anatomy, mineralogy, conchology, aboriginal history, and paintings. A claim to the discovery has since been set up in France.

Fixing and Colouring Portraits and Pictures.—It is very well known that some of the best and most beautiful portraits and pictures are found to fade, and consequently a large amount of attention has been given

to the best means for rendering them lasting. This has been found to be more particularly the case with photographs on paper, a want of visibility and a yellow tint in time spreading over the pictures. This matter is considered to be of so much importance, that the Council of the Photographic Society appointed a committee to inquire into the cause of failure, and to discover the best remedy. Light and moisture are looked on as among the causes contributive to failure; but the committee, after a long investigation, report that the most common cause of fading had been the presence of hyposulphite of soda, left on the paper from imperfect washing after fixing. The action of sulphuretted hydrogen gas in the London atmosphere is another cause; and they find that there is no known method of producing pictures which will remain unaltered under the continued action of moisture and atmosphere in London. The committee recommend that trials be made of substances likely to protect the prints from air and moisture, such as caoutchouc, gutta-percha, wax, and the various varnishes.

Experiments on Colour by Herschel, Hunt, Biot, and Becquerel.—Sir John Herschel states that, in 1840, he got some specimens of paper long kept, which gave a representation of the spectrum in its natural colours, giving light on a dark ground; but he was not prepared to say that they would prove an available process for coloured photographs, though it brought the hope nearer. Mr. Hunt informs us that he has obtained coloured pictures of the prismatic spectrum dark upon a light ground, and also on Daguerreotype tablets when iodized. In 1854, he obtained, on some paper prepared with the bichromate of potash and a weak solution of nitrate of silver, exposed behind four coloured glasses, blue, green, red, and yellow tints. M. Biot is of opinion that there are difficulties inherent in photographic pictures, which render the object illusive. M. Becquerel, on the other hand, reports that he has obtained bright impressions of the spectrum, and highly-coloured drawings, on metallic plates, prepared with chlorine.

Colouring Portraits and Pictures.—This is done upon the same system as miniature painting, but the colours are used in a dry powder.

How Long ought the Picture to be in the Camera?—This is a point determinable by practice, but in a good picture we should see first the whites of the dress, then the forehead of the sitter, and finally the whole of the face and dress. The time of exposure depends on the intensity of the light and focal length of the lens in sunshine.

Taking Likenesses after Death.—An American photographic firm announce that they not only take portraits of the living, but are prepared to take portraits after death.

Charles Maybury Archer.

THE GEOLOGY OF THE FIRESIDE—COAL.

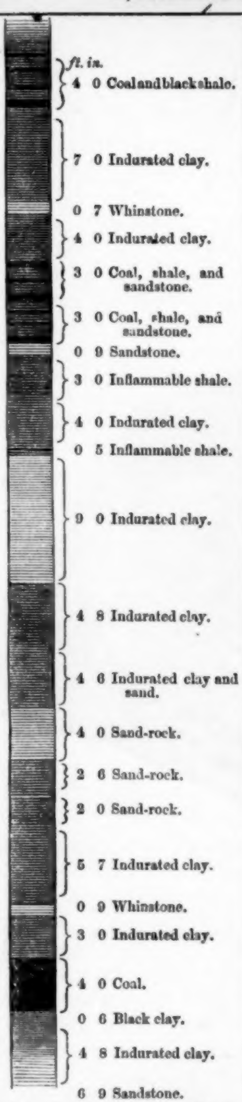
—o—

With shutters closed and curtains drawn against the blasts of the winter's wind, we sit in cheerful company around the homely hearth, enjoying merry gossip, as the sea-coal fire sends forth its cheerful blaze that makes our faces ruddy.

What stranger product of all the treasures of our mother-earth than coal? What countless years of manipulation has it undergone in the mysterious laboratory of Nature! What centuries of timber-growth, what ages of forests have been exhausted in the accumulation of its material! How far back in time did God's providence foresee the destiny of man, and lay up almost inexhaustible stores of fuel for his use? What would man be

without fire? With forests gone, and no knowledge of the mineral wealth that supplies their place, what would man have been,—what would he have accomplished? By fire he cooks his food, and becomes universal in the geographical distribution of his race. By fire he travels with almost lightning speed from realm to realm; by fire he raises into action gigantic machinery, and the most powerful of engines. And for the supply and maintenance of this fire he looks to coal,—to coal, the chemical and age-elaborated product of decayed and perished ferns, club-mosses, equisetacea and dicotyledonous trees (pines). How historic time seems dwarfed almost to nothingness, as we compare the length of our own age—the human—with the remoteness of that of the floral era of the coal formation. And yet time, measurable time, was long, long indeed before then. The glistening gneissic lands that first presented their rounded crests above the wide expanse of sea, had been covered over by tens of thousands of feet of Silurian sediments, the slow elaborate results of ages upon ages; hundreds of feet thick in the slow rolling on of time were the great Devonian conglomerates—mighty beaches of that primeval age—accumulated; the trilobites and grovelling shrimps and shell-fish of the lower rocks, the uncouth fish, and stranger huge crustaceans of the old red sandstone era had withered out as races in the long ceaseless stream of physical changes and events; three phases of terrestrial conditions had passed for ever clean away ere we come to, and ten phases of terrestrial conditions at least have been obliterated since, that period of luxuriant vegetation. But let us go back to the days of which we speak.

Scenic Illustration of an Ancient Coal-forest.*



Lign. 1.—Example of Coal-measures and Intermediate Strata.

Around the old Devonian uplands, covered with pines of sombre green, and feathery araucariæ, and studded with luxuriant groves of tree-ferns, the dark soil brought down by the great sludge-laden rivers, then draining a vast continent (lying to the west of our present island), of which we now know but fragmentary portions of its outlines, was daily spreading further and further, daily increasing the broad low shores rank with dense masses of vegetation that formed numberless tepid, humid jungles, dark and dismal. Amidst the dull lurid foliage, unenlivened by flowers, noisome insects bred, and through the mouldering putrescent swamps teeming with fungi sprouting from the rotten wood, sluggish-moving reptiles and great newt-like beasts crawled with hideous slimy limbs along, while in the black pools and lakes innumerable, the swarming shoals of harmless mud-fish raised swelling domes of inky water, as, flurried by the great megalichthys, or chased by other wolfish antagonists, they rushed for safety to take refuge amongst the dense tangles of matted trailing roots.

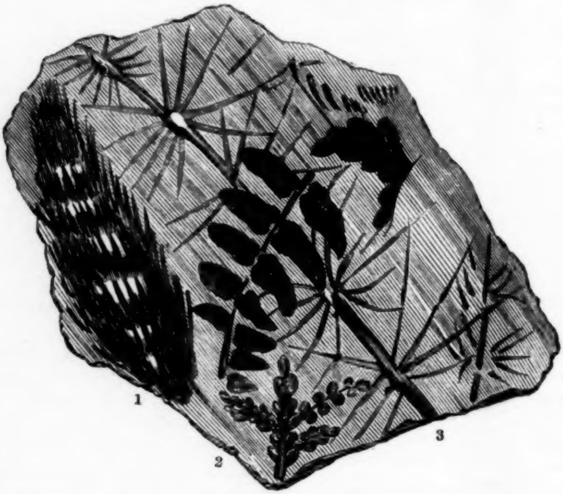
From the ruins of Nimroud some one brought away a brick, on which, beside the initial letter inscribed upon it, were the imprinted footsteps of a little weasel which had run over it before it was dried, and thus, though differently, the little animal and the mighty Assyrian king stamped the signs of their existence on the same common bit of clay. So some of the reptiles that lived in the rank groves and muddy lagoons of the carboniferous shores, but of which not a bone has yet been found, nor any other remains discovered, are known to us still by the track-marks of their ancient walks, preserved in the carboniferous shales amidst the wreck of sculptured lepidodendrons and pillar-like sigillariæ.

Now the descending land was won over by the tide and the rotting jungles buried under shelly sand, heaped up by ocean waves. Banks of encrinites and shells spread far inland over the estuary silts and peat bogs, to be again covered with dense vegetation, and again submerged. Again and again, by such alternations, was the carboniferous region made the platform of many successive stages of coal-material.

In the open sea the coral polypes were at their wondrous labours, and in its depths cephalopods crawled amongst densely-studded groups of spirifers, and other shells, while the degraded and decomposed debris of those lime-secreting creatures was gradually massed into bank upon bank of calcareous rock, examples of which are presented to us in the beautiful black and gray marbles of Ireland of Derbyshire, and of Belgium.

Similar banks of corals, shells, and encrinites stretched far away from Europe into India, and were widely extended in North and South America, as well as in the Arctic regions; and throughout all this wide range the coal-plants grew, and alternated with the sea, and marsh-formed beds.

Although we have given, in this brief sketch, an outline of the origin of coal, we may still ask what is coal? When the growth of centuries had formed forest masses, and the decayed trees, closely heaped in the great shallow bays, were floored in by the mud-floods of the rivers, or the silt of the sea, the heat of decomposition and the pressure of the sediment piled above, produced chemical changes which resulted in the bituminous matter of the rotting wood being separated or distilled as pure bitumen in innumerable minute globules, interspersed with vegetable fibre, and sometimes with mud. According to the intensity of the pressure exerted, and the quantity of foreign matter present, the bituminous particles partook more or less of a regular symmetrical semi-cylindrical form, like so many squeezed and out-drawn pasty pellets. In the course of time, when the carbonaceous matter took on a stony consistency, these compressed atoms, thus arranged side by side, gave that law of breakage of the coal-mass which is exhibited in the four planes of easy fracture presented to us in every block, and which we so commonly notice in the easy cleaving of well-warmed coals when we break up or stir a fire. In the fracture of coals, two planes of easiest cleavage are in a longitudinal direction parallel to the bedding of the coal, and two others are at right angles to these, and consequently across the smallest diameter of the particles.

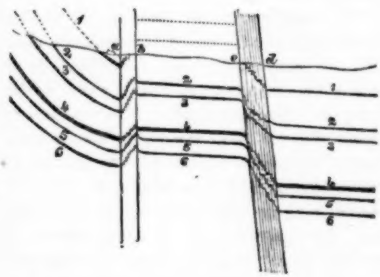


Lign. 2.—Coal-plants in "Stony Bind," from the Ashby Coal-field. 1. *Volckmannia disticha;* 2. (Middle specimen) *Neuropteris gigantea;* 3. *Asterophyllites longifolia.*

When the coal is very muddy, or much vegetable fibre retained, the particles of crystallized bitumen preserve their spherical

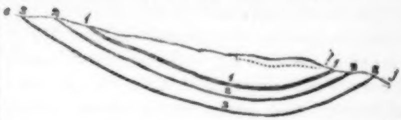
shape, and no such special directions of cleavage are exhibited, the lumps breaking like any homogeneous stone with an earthy fracture. We have now then simply explained the condition of coal, as well as why the hot coals flake in our grates.

But to return to our story. We have pictured the forest growth of coal-material; we have told how the sluggish rivers wandered down from the hills and plains, laden with sludge, depositing heaps of branches, stems, leaves, and trunks of pines and tree-ferns amongst the rotting jungles of calamites, lepidodendrons, and sigillariæ over the root-matted clay bottoms of sheltered marshes, cut off from the wide and open sea by shingle barriers and mud-banks; how these conditions alternated with influxes and over-coverings of the sinking land by the salt sea, and hence the alternations of the sandstones and limestones with the seams of coal. But then came a time when those regions were convulsed and shattered by tremendous earthquakes and violent volcanic outbreaks. The once continuous strata were dislocated, torn, broken up, and *faulted* by the uplift or down-



Example of "Upthrow"-fault, Ashby Coal-field. 1, 2, 3, 4, 5, 6, Seams of coal; *a b*, *c d*, lines of fault; *b c*, rock-mass upthrown; *e f*, present surface of country.

throw of the vast disrupted rock-masses, or squeezed, contorted, and thrown into *anticlinals*, and *synclinals*, into *troughs*, *basins*, or those smaller curvatures known amongst miners as "horses."* Porphyry, basalt, and other molten rocks were forced up into the



Example of a small Coal-basin in the Ashby Coal-field. 1, 2, 3, curved seams of coal forming the basin; *e f*, present surface of country.

fissures, forming dykes, or were exuded as lava-currents over the surface, or poured out on the sea-bottom, to be covered up by the Permian conglomerates and sandstones, by which the carboniferous deposits were succeeded, and which spread widely over the coal-measures, when the latter, broken and disrupted, had sunk beneath the waves. Thus was the once luxuriant scene obliterated, and the teeming soil made desolate and destroyed. Yet in all this seeming disorder and violence was the benevolence of the great Designer made manifest: by this temporary destruction, so to call it, of the carboniferous land, the coal-stores have been preserved; by these faults and dislocations the coal-measures have been made accessible over almost every region to man, and by these dykes and fissure-walls of molten matter the distinct and separate areas of coal-tracts have been made water-tight, and saved from inundation.

So marked, so marvellous, are the incidents in the formation, preservation, and the accessible presentation of the numerous compartments of the great storehouses of fossil-fuel, that we can hardly bring the mind to think they have been effected by the natural operation of natural physical forces; but we seem almost to be compelled to rest on an instinctive belief of a special ruling, or

* These latter in some cases only. Usually these minor subterranean ridges were formed during the coal period by the pressure of forests or other heavy weights causing a ridge on either side, equal to the force of the pressure; just as railway embankments, carried over oozy tracts, will cause a "rising" on either side of the line.

particular intervention, of the Higher Power, with a view to the future,—then how vastly future,—development of man. No bird, nor beast, nor living thing wants FIRE, but MAN; no other creature can make it, or use it, and f we admit design at all in the case of coal-formation, that design, that forethought must be *solely* for the human race, or there is no design at all.

As questions are commonly asked, and not always lucidly answered, as to the characteristic differences between the various kinds of coal, and other bituminous substances, we may briefly remark in this place, that *cannel coal* is a muddy coal, formed, probably, of a thin muddy wash of peaty matter; while *common coal* is chiefly composed of sigillariæ, and other ordinary carboniferous plants and trees, flattened and compressed together, and subjected to the bituminous distillation-process we have above described. *Anthracite* is coal divested of its hydrogen, which by some means, or by various processes, has been driven off.

Brown coal is a tertiary, and not a paleozoic deposit, and is in condition somewhat intermediate, perhaps, between peat and coal; as it retains very commonly so much of the woody structure and fibre as to be used, in Switzerland and other places on the Continent where it occurs, for beams, rafters, and other building-purposes, it might be concisely designated as bituminized wood.

S. J. MACKIE.

STUDIES OF COLOUR.

IN that suggestive fancy about putting the violet into a crucible, we read the apt expression of a poetic and naturally religious mind, and perceive its repugnance to anything like analysis of those matters which are supposed to lie within the province of "the beautiful." The poet's impatience of dogma was a part of that instinct which impelled him to declare that the ethereal graces of Nature are not fit subjects for the apparatus of the chemist. Investigation is, nevertheless, our sole way of approaching the knowledge of any kind of truth whatever; and though we may wisely be assured that there are mysteries lying deeper than the nerves and filaments, and ducts and valves, which form the mechanism of a smile or a tear—mysteries of sorrow and of joy which wholly elude the dissecting-knife of the anatomist—our reverential regard of the hidden cause need not interfere with the most scrutinizing and exact study of material agencies. Distinct and yet dependent phases of human thought are involved in the consideration of all objects. There are the joists and beams of the temple; there is the har monious proportion of the Builder's design; there is the faith which these things all subserve in their degree, and which bids us enter and adore.

In times when the division of employments had not been recognized as a principle, still less constructed into a system, art engaged the studious attention alike of the priest and the philosopher. Science and religion entered into the artist-life of those days. Questions which are now left to the arbitration of indefinite taste were formerly resolved by undeviating law. Such a question, for instance, as the arrangement of colours in a picture, or in an ornamental design, would have been referred to a standard from the decision of which there could be no appeal. The artisan—a term, by the by, which could never have been originated except in such days as we speak of—the artisan had constantly in view a surer guide than the few traditionary rules which are observed by modern workmen. Efforts

have of late been made to revive the true artistic spirit. Decorative artists, like Digby Wyatt, like Owen Jones, like Chevreul, have risen among us to protest against a condition of art no more reasonable than would appear in the practice, not hitherto ventured upon by musicians, of composing airs and harmonies without the slightest regard to the laws of thorough bass.

The name of Chevreul, mentioned by us in conjunction with the names of two eminent Englishmen, in each of whom the theory and practice of their art have met to admirably good purpose, may not be known to many readers of these pages. M. Chevreul is a French philosopher, who has devoted a great part of his life to the practical study of the numerous and intricate phenomena of colour. His book is an authority on the subject, and we are mainly indebted to it for the basis of all the statements contained in the present paper.*

M. Chevreul had attained a considerable reputation in his native country by his researches in organic chemistry, when, being appointed director of the dye-works of the Gobelins, he began to restrict his laborious investigations, which he now turned into a new and separate channel. A rigid inquiry into the optical as well as the chemical branch of the process under his superintendence was first suggested to him as an immediate necessity, by certain complaints of a want of strength in the black dyes employed, especially for the shadows of blue and violet draperies. He took great pains, first, to ascertain whether or not the dyes in use at the Gobelins were inferior to the dyes in use at the most celebrated works in France and other countries. His comparative experiments were sufficient to satisfy him that no inherent lack of vigour characterized the Gobelins' dyes. He was then led to suppose that the real fault belonged to colours which were brought into juxtaposition with the vilified black dyes, and that, in short, the whole question turned upon those phenomena which pertain to the contrast of colours. For ten years did M. Chevreul pursue an unremitting course of inquiry, the fruits of which will be found in the book we have mentioned. Observations on the aspect of coloured surfaces, verified by persons much practised in the judgment of colours, were collected by him as a basis of fact. In considering the relations of the various ascertained phenomena, and in seeking the principle in which they are founded, M. Chevreul appears to have made the discovery of what he terms the "law of simultaneous contrast of colours." This law, once demonstrated, becomes a means of assorting coloured objects, so as to obtain their best possible effect; it becomes a means also of estimating how far the eye is well organized for seeing and judging of colours, and whether painters have copied exactly the colours of natural objects. M. Chevreul's book has been justly called "an excellent example of the Baconian method of investigation." But the author does not, as Bacon did, claim for his system the merit of equalizing all students, and making each tyro a Titian. The extravagance ridiculed by Lord Macaulay, as being akin to the assumption that Lindley Murray, in his Grammar, shows how all men may write as well as Dryden, or that Whately's Logic and Rhetoric impart the secrets of arguing like Chillingworth, or speaking like Burke, finds no place in M. Chevreul's recommendation of his own inductive method. He is, nevertheless, entitled to the honour of having given the world a perfect grammar of the prismatic spectrum, and of having fully, clearly, and consecutively defined those principles by which the art-student, who cannot boast the highly organized natural instinct of a Titian, can alone approach to excellence in colour. Beyond the important service to

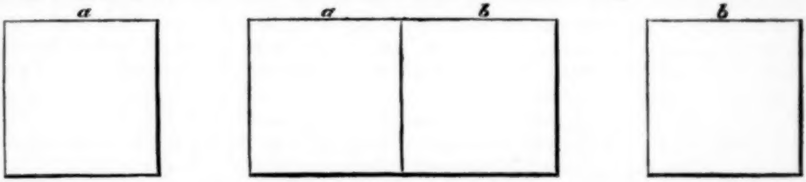
* "The Laws of Colour, and their Application to the Arts." By M. E. Chevreul. Translated by John Spanton. Third Edition. Routledge and Co.

pictorial art, we have to consider the value of lessons to all classes of students; for M. Chevreul pursues the subject through the several ramifications of painting, staining, dyeing, printing, the disposition of draperies and furniture, and the arrangement of natural objects, as in landscape and flower gardening.

Those who desire to compass the scientific principles of harmony and contrast, will do well to read with close attention the introductory chapters of M. Chevreul's book. We can but give a general idea of its utility. The law of simultaneous contrast is shown by a variety of experimental demonstrations, all of which are readily intelligible, and are of so pleasing a kind that the most casual student soon finds himself studying with an interest which expands and deepens at every fresh example. A ray of solar light is composed, as most people know, primarily of three rays—blue, red, and yellow—and indeterminately of various coloured rays, which, being distributed in groups, are termed red, orange, yellow, green, blue, indigo, and violet rays. When light falling on a body is completely absorbed by that body, as in falling into a deep cavity, then the body appears to us black, and it becomes visible to us only because of its contiguity with surfaces which reflect or transmit light. No bodies are known to be perfectly black; that is to say, no bodies exist which absorb light entirely; and it is just by their reflecting a little white light that we are enabled to discern their form in relief, like other material objects. When solar light is reflected by an opaque coloured body, there is a reflection of white light, and also a reflection of coloured light; the latter being accounted for by the fact, that the body absorbs or extinguishes within itself some of the coloured rays while reflecting the others. A moment's thought will bring us to the conclusion that, as the absorbed rays and the reflected rays must be of different colours, so their reunion produces white light again. In brief, it may be said, with regard to the physical composition of solar light, that if the whole of the coloured light absorbed by a coloured body were reunited with the whole of the coloured light which it reflects, white light would be the result. The phrase, "complementary colours," is used to express this property of two oppositely-coloured lights. Thus, we call red the complementary of green, because green, being combined blue and yellow, makes with red the complement of the prism. In the same manner blue is the complementary of orange (yellow and red); and yellow is the complementary of dark violet or purple (red and blue). With secondary and tertiary, as well as with primary tints, the same rule holds good; greenish yellow being the complementary of violet, and orange-yellow of indigo. Such are the leading facts, which, roughly laid down, will prepare the student for the consideration of many interesting phenomena, and for the pursuit of many instructive experiments.

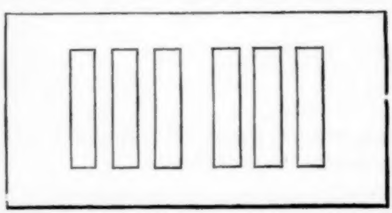
The simultaneous contrast of colours may be shown in several ways. If two stripes of the same colour, but of unequal tints, be placed together, so that the edges meet, we shall detect, if the stripes be not too broad, certain modifications, firstly affecting the intensity of the tints, and, secondly, the optical composition of the colours. To these modifications, inasmuch as they cause the colours to appear, when looked at together, more different than they really are, is applied this designation, "the simultaneous contrast of colours." The contrast of tone may be treated as a separate phenomenon, and we may gain some idea of this separate phenomenon by means of a simple, but very curious, series of experiments. Two square pieces of unglazed paper of a large size (*a a*), being coloured a clear gray, by a mixture of chalk and any black pigment, are to be affixed, at a space of rather more than half the width of either, on a piece of unbleached linen. Then two squares of paper of the same size (*b b*),

coloured, of a darker gray, are to be placed one with its edge against the edge of one of the pale gray squares, and the other at a distance corresponding with the space between the pale gray squares; so that a row of four

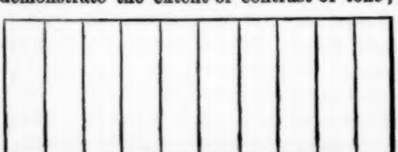


squares will be formed, the two middle squares abutting, and the two outer squares, one dark, the other pale, having spaces between them and the inner ones. When all this has been properly done, the light gray abutting on the dark gray will appear lighter than its isolated fellow, and *vice versa*.

The next step will be to demonstrate that the modification is not equal over the entire surfaces. By means of a card so cut as to divide each of the middle squares into three



parts, it will be found that the receding tints are again modified by distance. As a result of these two experiments, a third serves to demonstrate the extent of contrast of tone;



and this it does in a very remarkable manner. Ten stripes are to be indicated very slightly in pencil on a slip of paper, each stripe a quarter of an inch in width. Have ready in a saucer an evenly-mixed wash of any tint, with which lightly cover the whole of this series of stripes. When all the stripes are dry, a second wash is to be placed on all save the first stripe; then a third wash on all save the first and second; then a fourth wash on all the stripes but the first three; then a fifth wash, omitting the first four, and so on to the end, when the tenth stripe will be of a depth of ten washes, or shades, and all the remaining stripes down to the first will exhibit a gradual diminution of intensity. The scale being completed, a strange effect will be at once apparent. Instead of a series of *flat* tints, we have, as it seems, a channelled or fluted band; the edge of each stripe being lighter against the next dark edge, and darker against the next light edge. The natural deduction of the facts disclosed by these experiments will be that, as the contrast of colour is an infinitely more complex affair than the contrast of tone, so the calculations required in the arrangement or grouping of several hues must form a considerable part of the artist's duty. Intricate problems have to be solved before a pattern, consisting of colours unequally distributed, can be pronounced faultless. By reciprocal modifications, each affording material for study, it will be seen how, and in what degree, red inclines to violet, yellow, and orange; yellow inclines to green, red, and orange; blue inclines to indigo, violet, and green, and so on to the end of the seemingly endless chapter. The knowledge of all these modifications is as requisite to insure harmony in

the placing of colours, as the knowledge of thorough-bass is requisite to insure harmony in the score of a musical composition.

There is the harmony of analogy as well as the harmony of contrast. The distinction is best illustrated by reference to the dark and fair types of the human complexion. In the fair type we have the harmony of analogy, the colour of the skin being, although of a lower tone than the hair, analogous to it. The only actual contrast of colour in the fair type is afforded by blue eyes. Blondes ought, therefore, in the disposition of their toilettes, to carry out the principle dictated by the nature of their attractions. M. Chevreul recommends sky-blue as the colour that approaches nearest to the complementary of orange, which is the basis of the governing tint in the complexion of blondes. On the other hand, the black-haired type shows the harmony of contrast predominating over the harmony of analogy. Contrast being, in this case, the ruling principle, M. Chevreul points out that yellow and orange-red harmonize with the complexion of the brunette, while the complementaries violet and blue-green may be employed to assist the good effect. It is worthy a passing remark that the ex-fashionable colour, which is called "mauve," and which might just as well have been called by its English name, "mallow," inasmuch as it is the hue of the mallow-flower, is unsuitable alike to all complexions. It is a pretty colour of itself, but only in daylight. Neither by similitude nor by contrast will it harmonize with any tint in the human hair or skin.

The education of the eye need not be confined to plans and diagrams, however correct. It will be as safely, and with more likelihood of profit, carried on in the school of Nature. But, however carried on, an indispensable condition is, that natural laws shall be kept in sight; that "taste" shall not be allowed to overrule any of these laws; but shall acknowledge among them, and submit to be regulated by, the Laws of Colour.

Godfrey Turner.

RAPHIDES, OR MICROSCOPIC PLANT-CRYSTALS.

When the microscope came to be directed to the structure of plants, some minute crystals were occasionally found, that have since become objects of considerable interest. On the authority of Dr. Lindley, the first to have the pleasure of finding them was named Rafn, and the first plant in which they were met with *Calla Ethiopica*, the beautiful arum now so great a favourite as a window ornament and as a subject with designers. As to the right of priority, however, there seems some little doubt, our own adopted countryman Malpighi having observed crystals in the Indian fig (*Cactus opuntia*) at about the same time. They were long considered rare and curious objects; the latter they still, and always will remain, but it is interesting to observe how—

> "From small beginnings great events arise."

From being considered rare, the progress of research has shown that it would be more difficult to name plants in which they are not met with than the contrary. As an example of what may still be considered the typical form, those met with in the hyacinth may be named. If a portion of the flower-stem of this plant be cut or bruised over a glass slide, the exuding fluid will be found to contain many minute, delicate, transparent crystals, looking like so many fine needles sharply pointed at both ends (Fig. 1, A).

This resemblance at once suggested the name, from the Greek word *raphis*, a needle;

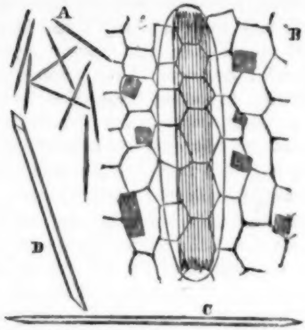


Fig. 1.—Acicular Raphides. A, from hyacinth; B, in tissue of squill bulb; C, one of the longest from squill; D, from orris-root.

it is now applied, with an extended meaning, to all crystalline concretions found in plants. As the hyacinth is not to be procured during a considerable portion of the year, the bulb of the medicinal squill (*Scilla maritima*), which can at any time be purchased, may be had recourse to. A moderately thin layer should be sliced off with a razor, parallel to the surface; with a few minutes' immersion in water the cells become so transparent as almost to lose their contours, and then the raphides may be distinctly seen in groups, looking like packets of fine needles, assorted in sizes (Fig. 1, D). Round each packet may generally be observed its wrapper, which might be compared to a very delicate bladder—in technical language, a wall of protoplastic material. When thus seen lying together, the difference in their size is one of the first points to catch the eye. To express in a familiar manner their relative length, it may be said that, of the smallest, if set end to end, a thousand would be required to bridge over the space of an inch, whilst of the largest about twenty-two only would be needed to cover the same.

The situation of raphides has formed a long-standing subject of controversy, some asserting that they were always situated in cells, whilst others maintained that they occurred in the intercellular passages. The latter are spaces left between the rounded cells of lax tissue. A good example of them is found in the carrot-root, by making a very thin section after it has become somewhat dry through being left about for a few days (Fig. 2). The reasoning that the raphides were longer than, and therefore could not be contained in, the cells of hyacinth, is very loose, and as it happens incorrect, since the cells in which they are found are much larger than ordinary.

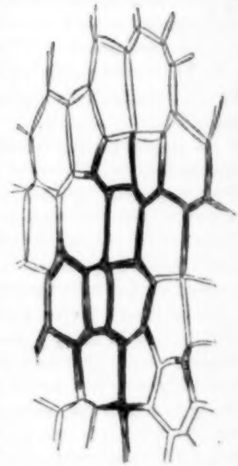


Fig. 2.—Intercellular Passages in Tissue of Root of Carrot; some are black from contained air.

But it is always desirable, when we can do it, to look at things as they grow, without any possibility of disturbance from cutting or tearing. In the walls of the anther of hyacinth they may be seen *in situ*, but they are most readily observed in the petals of œnothera, Clarkia, or epilobium. Take one of these, gently lay it on a slide with water and a covering glass; it is very delicate, rapidly becomes exceedingly hyaline, and then, standing sharply out from the rest of the structures, will be seen long, thick-walled cells, containing, though seldom filled with raphides. Large cells of a similar kind are found finely developed in the leaves of the banana, *Musa sp.* If thin sections of

the *Aroideæ*, of which the common Lords and Ladies, *Arum maculatum*, is a characteristic example, be examined in water, a curious sight will be presented; of the raphid-bearing cells one after another will be seen exploding and scattering its sharp-pointed missiles, as if engaged in deadly combat with an imaginary enemy. (A clever idea here for our brave volunteers!) The rupture of these cells is due to rapid imbibition of water by the mucilaginous matter they contain, along with the crystals.

In most of the lily tribe fine acicular crystals are formed. The root of the Florentine iris (orris-root) presents large stout ones (Fig. 1, D); in the vine, no part appears to be free, even the spiral vessels having been found invaded by them; in the testa of the seeds of garden balsam groups of them occur.

Crystals of a shorter form, united in bundles, abound in many plants; in all parts of rhubarb—root, stem, and leaves—they may be readily seen, and the acidity which is so highly prized in the spring-grown shoots for our pies and puddings, is due to the abundance of oxalic acid, mostly in crystalline form at that time. Conglomerate raphides of this kind are abundant in some of the

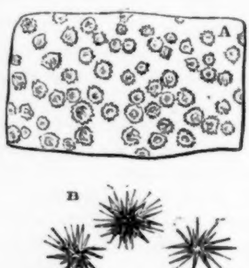


FIG. 3.—A, Cuticle of Indian Fig, with Stellate Raphides; B, some larger ones, from pulpy tissue of the fruit.

cacti. Every cell of the cuticle of *Opuntia* (Fig. 3, A) may be seen to possess, and be in great part filled, with its bundles of crystals; in the more pulpy portions of the fruit, where freer room for their development is afforded, they occur not only larger in size, but with much finer and sharper crystals (Fig. 3, B). As some of our friends have been unable to obtain "Raphides from a Pear," although slides so labelled are to be purchased, we take this opportunity of informing any who may not yet have learnt the secret that such are from this source, the Indian-fig cactus, or "prickly pear," as it is sometimes called. In *Cactus cochinellifer* the crystals are remarkable for their length and slenderness; in *C. cuneagonus* they are unusually large, and look more like flat plates grouped round a central nucleus.

The two forms of raphides, acicular and conglomerate, seldom occur together; the flower-stalk of *Pothos coriacea*, however, presents both in large numbers. In the bark and leaves of species of *Polygonum*, *Chenopodium*, *Atriplex*, etc., the conglomerate form is found in quantity.

Single, solitary crystals are much less commonly met with than either the grouped aciculi or conglomerate bundles; they occur, however, in bulbs of the onion and shallot, in the bark of the lime-tree, in that of the apple-tree, marked with lines apparently indicating stages of increase, in the testa of seed of the elm, and in that of the seed of black briony (*Tamus communis*).

Professor Quekett noticed, that after dissolving away the earthy salts from the raphides of a cactus, by acid, a cast, as it might be called, was still left in vegetable material, and surprise was expressed at the circumstance. The experiment is a pretty one, and easily repeated. The bark of the common orache (*Atriplex*) abounds with them, and from it a few of the crystals may be obtained by tearing up a portion with needles, on a slide. This is to be placed, having added water and a cover, on the stage of the microscope; with the attention fixed

on some two or three in particular, a small portion of muriatic acid is to be added by means of a glass rod. The raphides will be seen to lose their sharpness of outline, to become evidently altered, and in place of the bristling mass of crystals, a little lump of soft, structureless, vegetable material is left, proving the simultaneous deposition, atom for atom, of the organic and inorganic constituents. On this interesting fact, Mr. Rainey's recent researches* have thrown quite a new light. In a beautiful section of rhubarb-root, made by our friend, Mr. H. B. Brady, of Newcastle, the deposition of crystals in organic matter contained in the cells is very evident.

Another modification of raphides is met with in hemp, and many other plants of the nettle tribe (*Urticaceæ*), the mulberries, the India-rubber tree (*Ficus elastica*), and some others. These are called Cystolithes. When viewed as opaque they are very beautiful, and are not uncommon in cabinets of microscopic objects. No idea, however, can be formed of their true nature when seen in this condition. To understand how and where they are formed, let us take a leaf of pellitory of the wall (*Parietaria officinalis*), and make a vertical section (Fig. 4); we shall then find,

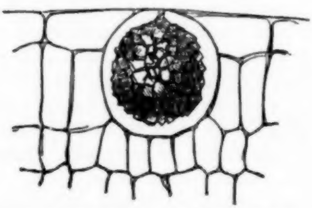


FIG. 4.—Vertical Section of Leaf of Pellitory, showing Cystolithe *in situ*.

amongst the ordinary tissue of the upper surface of the leaf, large cells, each of which contains a rounded, crystalline mass, dependent by a slender thread, of mucous material, from the upper wall of the cell. In the hemp, such occur on both sides of the leaf.

As to form, it may be briefly said that they are mostly four-sided prisms, terminated by pyramids, the section square or lozenge-shaped; octohedra sometimes occur, as may be seen in the pulpy portion of an orange. In their composition, lime is the chief base, united with oxalic, phosphoric, malic, citric, or tartaric acids. "The watery fluids traversing the tissues of growing plants, in consequence of evaporation from the leaves, and the continual absorption by the roots, necessarily contain various inorganic salts dissolved in them. Moreover, certain organic acids, such as malic, tartaric, etc., are always formed in the processes of vegetable digestion. All these substances and their compounds are, for the most part, dissolved in the cell-sap,"* but by mutual reaction they become precipitated in the crystalline form. For purposes of isolation, it may be, a delicate layer of protoplastic substance is then thrown round them. They are most abundant in the autumn. The vital powers, through the heats of summer, have kept the materials composing them in a state of solution; but these receive a check, the delicate balance is upset, and chemical affinities now assert their supremacy by the formation of myriads of crystals. This view is confirmed by some very interesting experiments, made a few years ago by Mr. Edwin Quekett, to show the possibility of their formation by artificial means. He saturated rice-paper with lime by repeated soakings in lime-water, and then placed portions in weak solutions of oxalic and phosphoric acids. From the former, masses of conglomerate raphides, precisely like those of rhubarb, were procured. In the cells of the latter were a few rhomboidal crystals. The conditions regulating develop-

* "On the Formation of Bone, Shell, etc." 8vo. Churchill.

* Henfrey, "Elementary Course of Botany."

ment in the acicular form were not successfully imitated.

Their uses are unknown. In the economy of the plants possessing them, they serve no apparent purpose, and may even be regarded rather as noxious products. It may be suggested that in some plants, at least, they serve the after-purpose of rendering the tissues brittle, and so facilitate decomposition. Their numbers are occasionally enormous—in rhubarb-root, out of every 100 grains of the best Turkey, 35 are these useless crystals, in East Indian 25, in English, such as is sold in the streets by men dressed up like Turks, 10—buyers of this drug judge of its quality by its grittiness. This has been considered a puzzle, but the explanation is simple: the same ardent suns that increase the quantity and power of the resinous purgative, *pari passû*, increase the amount of saline ingredients. A lime-tree having decayed, was cut down, the bark came off in large pieces, and as it fell, showers of dust came away, composed of the long, flattened prisms peculiar to it. Some of the cacti seem to become almost wholly composed of raphides. The two remarkable specimens of *Cereus senilis*, sent a few years ago from South America to Kew, will be in the recollection of all; these were supposed to be about one thousand years old, were so brittle as to fracture with a touch, and required packing in cotton wool, with all the care of the finest jewellery. A lively description, with sketches, was given in the *Illustrated London News* of the day.

Besides the higher plants, some of the ferns and mosses are stated to possess raphides, together with plants even lower in the scale. By favour of Mr. Shirley Hibberd, the opportunity has been afforded of examining a confervoid growth, detached by the action of frost from an aquarium. It was composed, principally, of the mucous investment of oscillatoria, with numerous compound crystals (Fig. 5) that dissolved rapidly in dilute muriatic acid, with much effervescence, leaving an organic residue.

Mr. F. Currey has lately met with acicular raphides in one of the lower fungi (*Phlebia mesenterica*), and has ascertained that crystals were formed rapidly and in immense numbers in a myriophillum, as the plant decayed. These were of the stellate form, and occurred in the intercellular passages. A good figure and description of them are given in the *Phytologist* for April, 1859.

Most raphides may be well preserved in

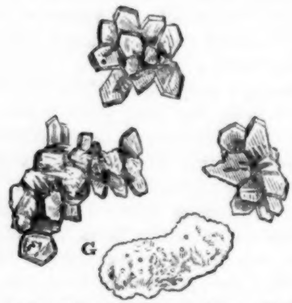


Fig. 5.—Crystalline Masses from Mucous Stratum of Oscillatoria. G, gelatinous substance left after dissolution of one by acid.

glycerine or Canada balsam, if it be not an object to show the tissues in which they have their seat. When mounted on a dead black ground, as opaque objects, dry, the stellate forms are especially beautiful. To obtain them clean for this purpose, the enveloping tissues must be entirely destroyed by maceration, the crystals repeatedly washed, and afterwards dried.

Some crystalline masses have been described as occurring in the stem of a fossil palm, which appeared to be raphides turned to stone!

Polarized light may be used with advantage in the examination of raphides. The play of the prismatic colours thus developed, is often very beautiful.

Tuffen West.

A CATALOGUE OF ALL THE COMETS WHOSE ORBITS HAVE HITHERTO BEEN COMPUTED.

(*Continued from page* 196.)

No.	Year.	PP.	π.	Ω.	ι.	q.	e.	μ.	Calculator.	Date of Discovery.	Discoverer.	Duration of Visibility.
		d. h.	° ′	° ′	° ′							
31	1533	June 14, 21	217 40	299 19	28 14	0·3269	...	+	Olbers	1533, June	P. Apian	2½ months.[1]
		June 16, 19	104 12	125 44	35 49	0·2028	...	−	Douwes			
(16)	1556	April 22, 0	274 14	175 25	30 12	0·5049	...	+	Hind	1556, Feb. 28	P. Fabricius	10 weeks.[2]
32	1558	Aug 10, 12	329 49	332 36	73 29	0·5773	...	−	Olbers	1558, July 14	Landgrave Hesse	6 weeks.
33	1577	Oct. 26, 22	129 42	25 20	75 9	0·1775	...	−	Woldstedt	1577, Nov. 1	In Peru	12 weeks.[3]
34	1580	Nov. 28, 13	109 12	19 8	64 52	0·5955	...	+	Pingré	1580, Oct. 2	Mœstlin	10 weeks.[4]
35	1582 ii.	May 6, 16	245 23	231 7	61 28	0·2257	...	−	Ditto	1582, May 13	Tycho Brahe	2 weeks.[5]
36	1585	Oct. 8, 0	9 8	37 44	6 5	1·0948	...	+	Peters	1585, Oct. 19	Do. & Rothmann	4 weeks.[6]
37	1590	Feb. 8, 0	217 57	165 36	29 29	0·5677	...	−	Hind	1590, Feb. 23	Tycho Brahe	3 weeks.[7]
38	1593	July 18, 13	176 19	164 15	87 58	0·1891	...	+	La Caille	1593, July 20	De Rissen	6 weeks.[8]
39	1596	July 25, 5	270 54	330 20	51 58	0·5671	...	−	Hind	1596, July 11	Mœstlin	5 weeks.[9]
(4)	1607	Oct. 27, 0	300 46	48 14	17 6	0·5841	0·96708	−	Lehman	1607, Sept. 11	Kepler	9 weeks.[10]
40	1618 i.	Aug. 17, 3	318 20	293 25	21 28	0·5129	...	+	Pingré	1618, Aug. 25	At Caschau	4 weeks.[11]
41	— ii.	Nov. 8, 8	3 5	75 44	37 11	0·3895	...	+	Bessel	— Nov. 10	Harriott, etc.	3 weeks.[12]
42	1652	Nov. 12, 15	28 18	88 10	79 28	0·8475	...	+	Halley	1652, Dec. 20	Hevelius	3 weeks.[13]
(30?)	1661	Jan. 26, 21	115 16	81 54	33 0	0·4427	...	+	Méchain	1661, Feb. 3	Ditto	5 weeks.[14]
43	1664	Dec. 4, 11	130 41	81 14	21 18	1·0258	...	−	Halley	1664, Nov. 17	In Spain	17 weeks.[15]
44	1665	April 24, 5	71 54	228 2	76 5	0·1064	...	−	Ditto	1665, Mar. 27	At Aix	4 weeks.[16]
45	1668	Feb. 24, 18	40 9	193 26	27 7	0·2511	...	+	Henderson	1668, Mar. 5	Gottignies, etc.	3 weeks.[17]
		Feb. 28, 19	277 2	357 17	35 58	0·0047	...	−	Ditto			
46	1672	March 1, 8	46 59	297 30	83 22	0·6974	...	+	Halley	1672, Mar. 2	Hevelius	7 weeks.[18]
47	1677	May 6, 0	137 37	236 49	79 3	0·2805	...	−	Ditto	1677, April 27	Ditto	12 days.[19]
48	1678	Aug. 18, 7	322 47	163 20	2 52	1·1453	0·62697	+	Le Verrier	1678, Sept. 11	La Hire	4 weeks.[20]
49	1680	Dec. 17, 23	262 49	272 9	60 40	0·0062	0·99998	+	Encke	1680, Nov. 14	Kirch	18 weeks.[21]
(4)	1682	Sept. 14, 19	301 55	51 11	17 44	0·5829	0·96792	−	Rosenberger	1682, Aug. 15	Flamsteed	5 weeks.[22]
50	1683	July 12, 17	86 31	173 17	83 47	0·5533	0·98324	+	Clausen	1683, July 23	Ditto	6 weeks.[23]
51	1684	June 8, 10	238 52	268 15	65 48	0·9601	...	−	Halley	1684, July 1	Bianchini	2 weeks.
52	1686	Sept. 16, 14	77 0	350 34	31 21	0·3250	...	+	Ditto	1686, Aug.	In India	1 month.[24]
53	1689	Nov. 29, 4	269 41	90 25	59 4	0·1893	...	−	Vogel	1689, Dec. 10	Richaud	2 weeks.[25]
54	1695	Nov. 9, 16	60 0	216 0	22 0	0·8435	...	+	Burckhardt	1695, Oct. 28	Jacob	3 weeks.[26]
55	1698	Oct. 18, 16	270 51	267 44	11 46	0·6912	...	−	Halley	1698, Sept. 2	La Hire	4 weeks.[27]
56	1699 i.	Jan. 13, 8	212 31	321 45	69 20	0·7440	...	−	La Caille	1699, Feb. 17	Fontenay	2 weeks.
57	1701	Oct. 17, 9	133 41	298 41	41 39	0·5926	...	−	Burckhardt	1701, Oct. 28	Pallu	1 week.[28]
58	1702 ii.	Mar. 13, 14	138 46	188 59	4 24	0·6468	...	+	Ditto	1702, April 20	Bianchini	2 weeks.[29]
59	1706	Jan. 30, 4	72 29	13 11	55 14	0·4258	...	+	La Caille	1706, Mar. 18	Cassini	4 weeks.
60	1707	Dec. 11, 23	79 54	52 46	88 36	0·8597	...	+	Ditto	1707, Nov. 25	Manfredi	8 weeks.[30]
61	1718	Jan. 14, 21	121 39	127 55	31 8	1·0254	...	−	Argelander	1718, Jan. 18	Kirch	3 weeks.

[1] According to Olbers, both these orbits will satisfy the observations, and it is as yet impossible to decide between them. It had a tail 15° long.

[2] A very fine comet, expected to return in 1860.

[3] It had a tail 22° long. This comet formed the subject of the observations of Tycho Brahe for the detection of parallax.

[4] Elements approximate. Observed also by Tycho Brahe.

[5] Very uncertain. It had a faint tail 3° long.

[6] This orbit was computed about 15 years ago, to see whether the comet of 1844 (ii) was identical with this one.

[7] It had a tail 7° long.

[8] It had a tail 4½° long.

[9] Discovered also by Tycho Brahe.

[10] An apparition of *Halley's comet*. It had a tail 7° long.

[11] Somewhat uncertain. Seen at Lintz, August 27, and by Kepler, September 1.

[12] A splendid comet; it had a tail, according to Longomontanus, 104° long, and of a reddish hue. Said to have been visible in the daytime.

[13] Elements only approximate.

[14] By some supposed to be identical with the comet of 1532; it was not reobserved, however, as was anticipated, about 1791.

[15] It had a tail from 6° to 10° long.

[16] It had a tail 25° long.

[17] Seen chiefly in the southern hemisphere; both orbits satisfy the observation, and it is impossible to say which is the correct one.

[18] It had a tail about 1° long.

[19] It had a tail about 6° long.

[20] Elements only approximate.

[21] A splendid comet, whose tail ultimately reached a length of from 70° to 90°. Halley conjectured that this was a return of the comet of 1106, 531—42 B.C., but this has since been shown to be unlikely. The orbit here given supposes a period of 8814 years; this, however, is subject to much uncertainty, inasmuch as the observation might possibly be satisfied by an 805 years' ellipse, or even by an hyperbolic orbit.

[22] An apparition of *Halley's comet*. It had a tail from 12° to 16° long.

[23] It had a tail varying from 2° to 4°. An elliptic orbit; period assigned, 190 years.

[24] Its nucleus was as bright as a first magnitude star, and had a tail 18° long.

[25] Observed very roughly in the East Indies. It had a tail 60° long. Pingré makes the Ω = 323° 45′.

[26] Observed still more imperfectly than the last in the southern hemisphere. It had a tail 18° long.

[27] Uncertain.

[28] Observed also by Thomas at Pekin.

[29] Very roughly observed; visible to the naked eye.

[30] Discovered by Cassini, November 29.

No.	Year.	PP.	π.	☊.	ι.	q.	e.	μ.	Calculator.	Date of Discovery.	Discoverer.	Duration of Visibility.
		d. h.	° ′	° ′	° ′							
62	1723	Sept. 27, 15	42 52	14 14	50 0	0·9987	...	−	Spörer	1723, Oct. 12	At Bombay	9 weeks.[31]
63	1729	June 13, 6	320 31	310 38	77 5	4·0435	1·00503	+	Burckhardt	1729, July 31	Sarabat	25 weeks.[32]
64	1737	Jan. 30, 8	325 55	226 22	18 20	0·2228	...	+	Bradley	1737, Feb. 6	In Jamaica	4 weeks.
65	— i.	June 8, 7	262 36	123 53	39 14	0·8670	...	+	Daussy	— Feb.	At Pekin	(?).[33]
66	1739	June 17, 10,	102 38	207 25	55 42	0·6735	...	−	La Caille	1739, May 28	Zanotti	11 weeks.
67	1742	Feb. 8, 4	217 35	185 38	66 59	0·7656	...	−	Ditto	1742, Feb. 5	Cape of G. Hope	13 weeks.[34]
68	1743 i.	Jan. 8, 4	93 19	86 54	1 53	0·8615	0·72130	+	Clausen	1743, Feb. 10	Grischau	2 weeks.[35]
69	— ii.	Sept. 20, 21	247 0	6 2	45 37	0·5229	...	−	D'Arrest	— Aug. 18	Klinkenberg	4 weeks.[36]
70	1744	March 1, 8	197 12	45 45	47 8	0·2220	...	+	Betts	— Dec. 9	Ditto	4 months (?)[37]
(15?)	1746	Feb. 15, 0	140 0	335 0	6 0	0·95	...	+	Hind	1746, Feb. 2	Kindermans	4 weeks.[38]
71	1747	March 3, 7	277 2	147 18	79 6	2·1985	...	−	La Caille	— Aug. 13	Chésaux	15 weeks.[39]
72	1748 i.	April 28, 18	215 20	232 51	85 28	0·8404	...	−	Le Monnier	1748, April 26	At Pekin	9 weeks.[40]
73	— ii.	June 18, 21	278 47	33 8	67 3	0·6253	...	+	Bessel	— May 19	Klinkenberg	4 days.[41]
74	1757	Oct. 21, 7	122 58	214 12	12 50	0·3375	...	+	Bradley	1757, Sept. 13	Bradley	5 weeks.[42]
75	1758	June 11, 3	267 38	230 50	68 19	0·2153	...	−	Pingré	1758, May 26	La Nux	5 months.
(4)	1759 i.	Mar. 12, 43	303 10	53 50	17 36	0 5845	0·96768	+	Rosenberger	— Dec. 25	Palitzch	5 months.[43]
76	— ii.	Nov. 27, 2	53 24	139 39	78 59	0·7885	...	+	La Caille	1760, Jan. 25	Messier	8 weeks.[44]
77	— iii.	Dec. 16, 21	138 24	79 50	4 51	0·9659	...	−	Ditto	— Jan. 7	At Lisbon	14 weeks.[45]
78	1762	May 28, 8	104 2	348 33	85 38	1·0090	...	+	Burckhardt	1762, May 17	Klinkenberg	6 weeks.[46]
79	1763	Nov. 1, 20	84 58	356 24	72 31	0·4982	0·99868	+	Ditto	1763, Sept. 28	Messier	8 weeks.[47]
80	1764	Feb. 12, 13	15 14	120 4	52 53	0·5552	...	−	Pingré	1764, Jan. 3	Ditto	6 weeks.[48]
81	1766 i.	Feb. 17, 8	143 15	244 10	40 50	0·5053	...	−	Ditto	1766, Mar. 8	Ditto	9 weeks.
82	— ii.	April 26, 23	251 13	74 11	8 1	0·3989	0·8640	+	Burckhardt	— April 1	Helfenzrieda	6 weeks.[49]
83	1769	Oct. 7, 14	144 11	175 3	40 45	0·1227	0·9992	+	Bessel	1769, Aug. 8	Messier	16 weeks.[50]
84	1770 i.	Aug. 14, 0	356 16	131 59	1 34	0·6743	0·78683	−	Le Verrier	1770, June 14	Ditto	15 weeks.[51]
85	— ii.	Nov. 22, 5	208 22	108 42	31 25	0·5282	...	+	Pingré	1771, Jan. 10	La Nux	11 days.[52]
86	1771	April 19, 5	104 3	27 51	11 15	0·9034	1·00936	+	Encke	— April 1	Messier	15 weeks.[53]
87	1772	Feb. 8, 0	97 21	263 24	17 39	0·9118	0·67692	+	Gauss	1772, Mar. 8	Montagno	3 weeks.[54]
88	1773	Sept. 5, 14	75 10	121 5	61 14	1·1268	...	+	Burckhardt	1773, Oct. 12	Messier	27 weeks.[55]
89	1774	Aug. 15, 19	317 27	180 44	83 20	1·4328	1·02829	+	Ditto	1774, Aug. 11	Montagne	11 weeks.[56]
90	1779	Jan. 4, 2	87 14	25 4	32 30	0·7131	..	−	Zach	1779, Jan. 6	Bode	19 weeks.[57]
91	1780 i.	Sept. 30, 22	246 35	123 41	54 23	0·0963	0·99994	−	Clüver	1780, Oct. 26	Messier	5 weeks.[58]
92	— ii.	Nov. 28, 20	246 52	141 1	72 3	0·5152	...	−	Olbers	— Oct. 18	Montagne	3 days.[59]
93	1781 i.	July 7, 4	239 11	83 0	81 43	0·7758	...	+	Méchain	1781, June 28	Méchain	3 weeks.
94	— ii.	Nov. 29, 12	16 3	77 22	27 13	0·9610	...	−	Ditto	— Oct. 9	Ditto	11 weeks.[60]
95	1783	Nov. 19, 13	49 31	55 12	47 43	1·4953	0·6784	+	Burckhardt	1783, Nov. 19	Pigott	4 weeks[61]
96	1784 i.	Jan. 21, 4	80 44	56 49	51 9	0·7078	...	−	Méchain	— Dec. 15	La Nux	23 weeks.[62]
97	— ii.	March 10, 0	137	35	84	0·637	...	+	Burckhardt	1784, April 10	D'Angos	5 days.[63]
98	1785 i.	Jan. 27. 7	109 51	264 12	70 14	1·1434	...	−	Méchain	1785, Jan. 7	Messier	5 weeks.
99	— ii.	April 8, 8	297 29	64 33	87 31	0·4273	...	−	Ditto	— Mar. 11	Méchain	5 weeks.[64]
100	1786 i.	Jan. 30, 20	156 38	334 8	13 36	0·3348	0·84836	−	Encke	1786, Jan. 17	Ditto	3 days.[65]
101	— ii.	July 7, 21	159 25	194 22	50 54	0·4101	...	+	Méchain	— Aug. 1	Miss Herschel	12 weeks.
102	1787	May 10, 19	7 44	106 51	48 15	0·3489	...	−	Saron	1787, April 10	Méchain	7 weeks.
103	1788 i.	Nov. 10, 7	99 8	156 56	12 27	1·0630	...	−	Méchain	1788, Nov. 25	Messier	5 weeks.[66]

[31] Afterwards seen in Europe, with a faint tail 1° long.

[32] Scarcely perceptible to the naked eye. The orbit is a hyperbolic one, and remarkable for its enormous perihelion distance, the greatest known.

[33] Elements only approximate.

[34] Visible to the naked eye, with a tail 6° or 8° long.

[35] Very imperfectly observed. An elliptic orbit; period assigned, 5·436 years.

[36] Very uncertain. Visible to the naked eye.

[37] The finest comet of the eighteenth century. On February 15 it had a bifid tail, the eastern portion being 7° long, and the western 24°. Visible in a telescope in the daytime. Euler has calculated an elliptic orbit, to which he assigns a period of 122,683 years!!! The statement of this comet having had six tails is believed to be a fabrication.

[38] Elements uncertain, but they strongly resemble those of the comet of 1231. It passed very near the earth.

[39] Observed only during 1746.

[40] Discovered by Maraldi, April 30. Visible to the naked eye, with a tail 20° long.

[41] Very uncertain.

[42] Elements tolerably reliable. It had a small tail.

[43] The first *predicted* apparition of *Halley's comet*. On May 5, its tail was 47° long.

[44] Visible to the naked eye, with a tail 5° long.

[45] This comet came near the earth, and moved with great rapidity; it had a tail 4° long.

[46] It had a small tail.

[47] An elliptic orbit. Period assigned, 7334 years. Lexell makes it 1137 years.

[48] Visible to the naked eye, with a tail 2¼° long.

[49] Discovered by Messier, April 8. An elliptic orbit. Period assigned, 5·025 years. Visible to the naked eye, with a tail 3° or 4° long.

[50] Visible to the naked eye, with a tail from 60° to 80° long. Bessel assigns 2090 years as the most likely period of revolution. He has shown that an error of 5″ either may increase the period to 2673 years, or diminish it to 1692 years.

[51] The celebrated *Lexell's comet*. The diameter of the head, July 1, was 2¼°. It had also a small tail, and approached within 1,400,000 miles of the earth.

[52] It had a faint tail, 5° long.

[53] The orbit of this comet is undoubtedly hyperbolic. It had a tail about 2° long.

[54] The first recorded apparition of *Biela's comet*.

[55] Just perceptible to the naked eye.

[56] A hyperbolic orbit.

[57] Discovered by Messier, January 18.

[58] An elliptic orbit. Period assigned, 75,314 years.

[59] Discovered by Olbers on the same day.

[60] Visible to the naked eye, November 9, with a tail 3° long. It came very near the earth.

[61] An elliptic orbit. Period assigned, 5·613 years.

[62] Visible to the naked eye, with a tail 2° long.

[63] Not only are the elements uncertain, but it is doubtful whether the comet ever existed.

[64] Visible to the naked eye, with a tail 9° long.

[65] The first recorded apparition of *Encke's comet*.

[66] Visible to the naked eye, with a tail 2¼° long.

No.	Year.	PP.	π.	☊.	ι.	q.	e.	μ.	Calculator.	Date of Discovery.	Discoverer.	Duration of Visibility.
		d. h.	° ′	° ′	° ′							
104	1788 ii.	Nov. 20, 7	22 49	352 24	64 30	0·7573	...	+	Mé hain	1788, Dec. 21	Miss Herschel	4 weeks.
105	1790 i.	Jan. 15, 5	60 14	176 11	31 54	0 7581	...	—	Saron	1790, Jan. 7	Ditto	2 weeks.[67]
106	— ii.	Jan. 28, 7	111 48	267 8	56 58	1·0632	...	+	Méchain	— Jan. 9	Méchain	3 weeks.
107	— iii.	May 21, 5	273 43	33 11	63 52	0·7979	...	—	Ditto	— April 18	Miss Herschel	10 weeks.[68]
108	1792 i.	Jan. 13, 13	36 29	190 46	39 46	1·2930	...	—	Ditto	1791, Dec. 15	Ditto	6 weeks.
109	— ii.	Dec. 27, 6	135 59	283 15	49 1	0·9662	...	—	Prosperin	1793, Jan. 8	Gregory	6 weeks.[69]
110	1793 i	Nov. 4, 20	228 42	108 29	60 21	0·4034	...	—	Saron	— Sept. 27	Messier	15 weeks.
111	— ii.	Nov. 28, 5	71 54	2 0	51 31	1·4951	0·97342	+	D'Arrest	— Sept. 24	Perny	10 weeks.[70]
(100)	1795	Dec. 21, 10	156 41	334 39	13 42	0·3344	0·84888	+	Encke	1795, Nov. 7	Miss Herschel	3 weeks.[71]
112	1796	April 2, 19	192 44	17 2	64 54	1·5781	...	—	Olbers	1796, Mar. 31	Olbers	2 weeks.[72]
113	1797	July 9, 2	49 27	329 15	50 40	0·5266	...	—	Ditto	1797, Aug. 14	Bouvard	3 weeks.[73]
114	1798 i.	April 4, 11	104 59	122 9	43 52	0·4847	...	+	Burckhardt	1798, April 12	Messier	6 weeks.
115	— ii.	Dec. 31, 13	34 27	249 30	42 26	0·7795	...	—	Ditto	— Dec. 6	Bouvard	1 week.[74]
116	1799 i.	Sept. 7, 5	3 39	99 32	50 56	0·8399	...	—	Ditto	1799, Aug. 7	Méchain	3 weeks.[75]
(56)	— ii.	Dec. 25, 21	190 20	326 49	77 1	0·6258	...	—	Méchain	— Dec. 26	Ditto	10 days.[76]
117	1801	Aug. 8, 13	183 49	44 28	21 20	0·2617	...	—	Burckhardt	1801, June 30	Reissig	3 weeks.[77]
118	1802	Sept. 9, 21	332 9	310 15	57 0	1·0941	...	+	Olbers	1802, Aug. 26	Pons	6 weeks.[78]
119	1804	Feb. 13, 15	148 53	176 49	56 44	1·0772	...	+	Bouvard	1804, Mar. 7	Ditto	3 weeks.[79]
(100)	1805	Nov. 21, 12	156 47	334 20	13 33	0·3404	0·84617	+	Encke	1805, Oct. 19	Thulis	3 weeks.[80]
(87)	1806 i.	Jan. 1, 23	109 32	251 15	13 38	0·9068	0·74578	+	Gambart	— Nov. 10	Pons	4 weeks.[81]
120	— ii.	Dec. 28, 22	97 2	322 19	35 2	1·0815	...	—	Burckhardt	1806, Nov. 10	Ditto	14 weeks.
121	1807	Sept. 18, 17	270 54	266 47	63 10	0·6461	0·99548	+	Bessel	1807, Sept. 9	Parisi	28 weeks.[82]
122	1808 i.	May 12, 22	69 12	322 58	45 43	0·3898	...	—	Encke	1808, Mar. 25	Pons	1 week [83]
123	— ii.	July 12, 4	252 38	24 11	39 18	0·6079	...	—	Bessel	— June 24	Ditto	10 days.[84]
124	1810	Oct. 5, 19	63 9	308 53	62 46	0 9691	...	+	Ditto	1810, Aug. 22	Ditto	6 weeks.
125	1811 i.	Sept. 12, 6	75 0	140 24	73 2	1·0354	0·99509	—	Argelander	1811, Mar. 26	Flaugergues	17 months.[85]
126	— ii.	Nov. 10, 23	47 27	93 1	31 17	1·5821	0·98271	+	Nicolai	— Nov. 16	Pons	13 weeks.[86]
127	1812	Sept. 15, 7	92 18	253 1	73 57	0·7771	0 95454	+	Encke	1812, July 20	Ditto	10 weeks.[87]
128	1813 i.	Mar. 4, 12	69 56	60 48	21 13	0·6901	...	—	Nicollet	1813, Feb. 4	Ditto	5 weeks.
129	— ii.	May 19, 10	197 43	42 40	81 2	1·2161	...	—	Encke	— Mar. 21	Ditto	6 weeks.[88]
130	1815	April 25, 23	149 1	83 28	44 29	1·2128	0·93121	+	Bessel	1815, Mar. 6	Olbers	25 weeks.[89]
131	1816	May 1, 8	267 35	323 14	43 5	0·0485	...	+	Burckhardt	1816, Jan. 22	Pons	11 days.[90]
(87)	1818 i.	Feb. 7, 9	95 7	254 0	20 2	0·7332	...	+	Pogson	1818, Feb. 23	Ditto	4 days.[91]
132	— ii.	Feb. 25, 23	182 45	70 26	89 43	1·1977	...	+	Encke	1817, Dec. 26	Ditto	18 weeks.
133	— iii.	Dec. 4, 22	101 55	89 59	63 5	0·8550	...	—	Rosenberger	1818, Nov. 28	Ditto	9 weeks.[92]
(100)	1819 i.	Jan. 27, 6	156 59	334 33	13 36	0·3352	0·84858	+	Encke	— Nov. 26	Ditto	7 weeks.[93]
134	— ii.	June 27, 17	287 5	273 42	80 44	0·3410	...	+	Bouvard	1819, July 1	Tralles	16 weeks.[94]
135	— iii.	July 18, 21	274 40	113 10	10 42	0·7736	0·75519	+	Encke	— June 12	Pons	5 weeks.[95]
136	— iv.	Nov. 20, 5	67 18	77 13	9 1	0·6925	0·69674	+	Encke	— Nov. 28	Blanpain	8 weeks.[96]

[67] Imperfectly observed on four occasions. Elements but approximate.

[68] Visible to the naked eye, with a tail 4° long.

[69] Discovered by Méchain and Piazzi, January 10. There was a trace of a tail to be seen.

[70] Discovered by Miss Herschel, October 7. An elliptic orbit. Period assigned, 422 years.

[71] An apparition of *Encke's comet*. It was just visible to the naked eye.

[72] Very faint.

[73] Discovered by Miss Herschel, and Lee on the same evening; by Rudiger, August 15, and by Kecht, August 16.

[74] Discovered by Olbers, December 28. Elements only approximate.

[75] Discovered by Olbers, August 26. At first faint, but afterwards visible to the naked eye, with a tail 1° long.

[76] Probably a return of the comet of 1699. Visible to the naked eye, with a tail from 1° to 3°.

[77] Discovered at Paris, July 12. The observations were very rough.

[78] Discovered by Méchain, August 28, and by Olbers, September 2.

[79] Discovered by Bouvard, May 10, and by Olbers, May 12.

[80] An apparition of *Encke's comet*. Discovered by Pons and Bouvard, October 20, and by Huth some days afterwards. Visible to the naked eye, with a tail 3° long.

[81] An apparition of *Biela's comet*. Discovered by Bouvard, November 16, and by Huth, November 22. Visible to the naked eye.

[82] Discovered by Pons, September 20. It was visible to the naked eye, with a tail 5° long, an elliptic orbit. Period assigned, 1714 years, which may, however, be extended to 2157 years, or reduced to 1404 years.

[83] Discovered by Wisniewski, March 29.

[84] Elements only approximate.

[85] A very celebrated comet, conspicuously visible in the autumnal evenings of 1811. It had a tail 25° long, and 6° broad. The most reliable computations assign a periodic term of 3065 years, subject to an uncertainty of not more than 43 years. The orbit of this comet is liable to much planetary perturbation.

[86] An elliptic orbit. Period assigned, 875 years. Visible to the naked eye.

[87] An elliptic orbit. Period assigned, 70·68 years. Visible to the naked eye, with a tail 2° long.

[88] Discovered also by Harding. Visible to the naked eye.

[89] An elliptic orbit. Period assigned, 70·049 years. Bessel anticipates that planetary perturbation will bring it back to perihelion, 1887, February 9. It had a short tail.

[90] Elements only approximate.

[91] An apparition of *Biela's comet*. The observations were few and indifferent.

[92] Discovered by Bessel, December 23. It moved very rapidly. Rosenberger has computed a hyperbolic orbit.

[93] An apparition of *Encke's comet*, whose periodicity was now discovered.

[94] A very brilliant comet, with a tail 7° long.

[95] An elliptic orbit. Period assigned 5·618 years. Considered by Clausen as a return of the comet of 1766 (ii).

[96] Discovered by Pons, Dec. 4. An elliptic orbit; period assigned, 4·810 years. Clausen thought this comet might be identical with that of 1743 (i).

(*To be continued.*) GEO. F. CHAMBERS.

METEOROLOGY OF FEBRUARY.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1842	50·0	26·0	—
1843	48·0	15·7	2·3
1844	48·5	17·0	2·2
1845	47·5	20·0	0·7
1846	58·0	28·0	0·8
1847	54·0	20·0	1·4
1848	56·5	23·2	3·6
1849	57·5	23·0	0·9
1850	57·0	26·0	1·3
1851	61·0	23·5	0·5
1852	55·5	22·5	1·8
1853	42·5	18·8	1·1
1854	56·0	24·8	0·8
1855	39·7	6·1	1·5
1856	57·8	21·9	1·9
1857	57·5	19·5	0·7
1858	51·0	20·5	0·3
1859	57·2	27·4	1·2

The greatest heat in shade reached 61·0° in 1851, and only 39·7° in 1855, giving a range of 21·3° in greatest heat for February during the past eighteen years.

The greatest cold was as low as 6·1° (or 25·9° of frost) in 1855, and never below 28·0° in 1846, giving a range of 21·9° for February during the past eighteen years. The coldest years were 1843, 1844, 1845, 1847, 1853, 1855, and 1857; and the warmest, 1842, 1846, 1850, and 1859. In 1855 the temperature fell 9·6° lower than in any other year.

Only 0·3 inch of rain fell in February, 1858, and as much as 3·6 inches in 1848, giving a range of 3·3 inches for February, during the past seventeen years. The mean fall of rain for February is 1·4 inches. In seven years the fall was less than one inch, and in three years it exceeded two inches. E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR FEBRUARY, 1860.

The sun is in Aquarius until the 19th, when he passes into Pisces. He rises in London on the 1st at 7h. 42m., on the 10th at 7h. 27m., on the 20th at 7h. 8m., and on the 29th at 6h. 49m. He sets in London on the 1st at 4h. 46m., on the 10th at 5h. 3m., on the 20th at 5h. 21m., and on the 29th at 5h. 37m.

The sun reaches the meridian on the 1st at 12h. 13m. 49s.; on the 15th at 12h. 14m. 25s., and on the 29th at 12h. 12m. 42s.

The equation of time on the 1st, 13m. 49s.; on the 15th, 14m. 25s.; and on the 29th, 12m. 42s.; the clock being these amounts before the sun, *i. e.*, the equation of time addative.

At Edinburgh and Glasgow the sun rises on the 1st 17 minutes later, and on the 15th 12 minutes later than in London, and sets on the 1st 17 minutes earlier, and on the 15th 12 minutes earlier. At Dublin and Liverpool he rises 7 minutes later, and sets 7 minutes earlier than in London, and on the 15th, 5 minutes; whilst at Exeter and Portsmouth he rises on the 1st, 3 minutes earlier, and sets 3 minutes later than in London, and on the 15th 2 minutes.

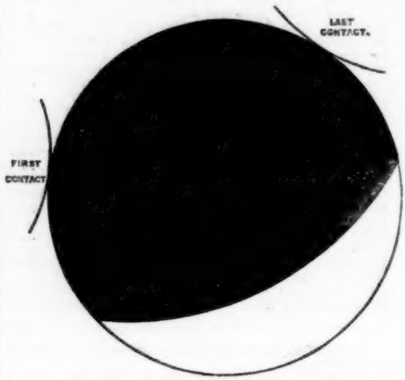
Day breaks on the 3rd at 5h. 42m., on the 28th at 4h. 57m. Twilight ends on the 13th at 6h. 49m.

The moon is full on the 7th at 2h. 35m. a.m.

New moon on the 21st at 7h. 39m. p.m.

The moon is nearest to the earth on the 7th, and most distant on the 21st. Near Jupiter on the 5th.

There will be a lunar eclipse on the 7th, and at the time of greatest phase (2h. 29m. a.m.) four-fifths of the moon's diameter will be obscured, *i. e.*, 0·809 (moon's diameter = 1·000). It begins at 1h. 2m. a.m.,



Eclipse of the Moon, at Greenwich, Feb. 7th, 2h. 29m. a.m.

and ends at 3h. 56m. a.m. First contact with the shadow 79° from the northernmost point of moon's limb towards the east, and last contact 32° towards the west. (For direct image.)

Mercury is in Capricornus, passing into Aquarius at the end of the month; he is unfavourably situated for observation.

Venus is in Aquarius at the beginning, and in Pisces at the end of the month. She is still unfavourably situated for observation. She sets on the 10th at 8h. 4m. p.m., and on the 20th at 8h. 35m. p.m.

Mars is very badly situated for observation. He is in Scorpio at the beginning, and in Ophiuchus at the end of the month, rising on the 10th at 2h. 48m. a.m.

Jupiter is a fine telescopic object; he is in Gemini, rising on the 10th at 6h. 6m., and on the 20th at 5h. 24m. p.m., being on the meridian on the 10th at 9h. 51m. p.m., and on the 20th at 9h. 9m. p.m.

Saturn is also favourably situated for observation, especially on the 11th. He is in Leo, rising on the 10th at 4h. 58m. p.m.

Uranus is in a favourable situation for observation, a little above the Hyades in Taurus.

There are no occultations of stars by the moon of a greater magnitude than the 5th :—

Eclipses of Jupiter's satellites at Greenwich :—On the 2nd, at 2h. 57m. 49s. a.m., 2nd moon reappears. On the 7th, at 1h. 51m. 57s. a.m., 1st moon reappears. On the 8th, at 7h. 20m. 42s. p.m., 1st moon reappears. On the 11th, at 8h. 9m. 54s. p.m., 3rd moon reappears. On the 12th, at 6h. 52m. 24s. p.m., 2nd moon reappears. On the 14th, at 2h. 46m. 49s. a.m., 1st moon reappears. On the 15th, at 9h. 15m. 37s. p.m., 1st moon reappears. On the 18th, at 8h. 50m. 23s. p.m., 3rd moon disappears. On the 19th, at 12h. 10m. 8s. a.m., 3rd moon reappears. On the 19th, at 9h. 28m. 53s. p m., 2nd moon reappears. On the 21st, at 1h. 45m. 40s. a.m., 4th moon disappears. On the 22nd, at 11h. 10m. 39s. p.m., 1st moon reappears. On the 26th, at 12h. 50m. 5s a.m., 3rd moon disappears. On the 27th, at 12h. 5m. 17s. a.m., 2nd moon reappears.

At 11 p.m., meantime, on the 14th and 21st, the first satellite is on the disc of Jupiter, and on the 17th, at the same hour, the second satellite is on the disc.

E. J. Lowe.

THINGS OF THE SEASON—FEBRUARY.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

—o—

Birds Arriving.—Occasional flights of Hooper Swans, and other water-fowl, but no distinct arrivals of migratory birds.

Birds Departing.—Gray Lagg, Bernacle, Laughing, and Brent Geese; Goosander; Pin tailed, Scaup, Velvet, Black, and Eider Ducks; Gadwell, Black-throated and Red-throated Divers; Wild Swan; Common, Bar-tailed, and Green-shanked Godwits; Sea Curlew, White-headed Smew, Silktail, Sanderling, Golden Plover, Golden-eyed Pocher, Stock Dove, Dartford Warbler, Mountain Finch, Siskin, Lesser Guillemot, Knot, Purre.

Insects.—Hydrophilus caraboides, Berosus luridus, Dermestes lardarius, 7-spotted Ladybird, Meal-worm Beetle, Orange Upper Wing, February Carpet.

Wild Plants in Flower.—Snowdrop, Stinking Bear's-foot, Great Henbit, Whitlow Grass, Groundsel, Common Furze, Colt's-foot, Dandelion, Hepatica, Mezereon, Primrose, Creeping Crowfoot, Butcher's-broom.

Mr. Noteworthy's Corner.

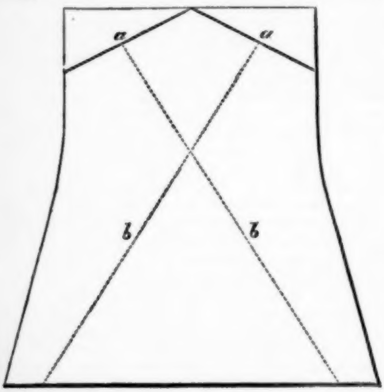
Optical Phenomenon.—There is a somewhat curious optical phenomenon to be seen in the chapel attached to the cemetery at Tottenham, and probably in other buildings, whose windows are similarly constructed, which has not, that we are aware of, been hitherto described or explained. In the middle of the windows there is a lozenge-shaped casement opening, through which, when open, the sky, trees, clouds, and houses appear of a bluish tint. This appearance may be explained in the following manner :—It is well known that every colour has what is called its accidental, or complementary colour, or that colour which, together with a given colour, would form white light. Thus, if the eye looks steadily at a red wafer on a sheet of white paper, it will, when turned away from the wafer, see the image of a green wafer. If the wafer were blue, it would afterwards see the image of an orange wafer. If it were orange-coloured, it would afterwards see the image of a blue one, and so on. Now the glass of the chapel-windows is of an orange-yellow tint, hence the general light inside the chapel is of an orange-yellow colour, and, therefore, the eye through the uncoloured opening sees the landscape outside tinted with the accidental or complementary colour of orange-yellow, which is blue. If the glass were green, the landscape would appear of a reddish tint, and so on. It is also a curious fact, that when the sun shines through the opening, it gives the different objects on which it shines a blue tint, which is to be explained in the same way. Perhaps the above phenomenon might suggest the idea of forming a philosophical toy, for explaining and showing some of the properties of light, by fixing coloured glasses, with a small hole in the middle, at the end of a tube.

Hunt's Cinephantic Colour-Top.—Mr. Noteworthy has read with much interest a paper on this invention read by Mr. Edmund Hunt before the Philosophical Society of Glasgow on the 16th of November last, and which is printed in the society's proceedings. This colour-top is distinct from Mr. Gorham's, and, according to Mr. Hunt's view of its action, Mr. Gorham is wrong in the explanation he gives of the *rationale* of the phenomena produced by the Kaleidoscopic Top. It is impossible to condense the substance of Mr. Hunt's paper into a paragraph, and Mr. Noteworthy recommends all who take a practical interest in the subject to obtain the full text of Mr. Hunt's essay. He thinks well of Mr. Goodchild's clockwork, to which, nevertheless, he would make additions, so as to produce the same effect as those which result from the so-called "rapid and regular jerks," by "applying a perfectly continuous motion to the loose disc." He thinks Mr. Goodchild's Top should be made with frictional wheels instead of toothed wheels, and that "the best application of wheelwork would be to reproduce the experiments on a large scale, and with the discs vertical, so as to be seen by a large audience. The experiments might also be exhibited by the magic lantern."

The New Intra-Mercurial Planet.—Much interest is now being felt, in the astronomical world, on account of the supposed discovery of a new inferior planet revolving round the sun, within the orbit of Mercury. Public attention was first drawn to the subject by a communication forwarded to the Academy of Sciences at Paris, in September last, by M. Le Verrier, in which he announced that a certain error in the perihelion element of Mercury's orbit could only be ex-

plained on the supposition of the existence of another and interior perturbing planet. The suspected planet has been found; it was discovered transiting the sun's disc on March 26, 1859, by M. Lescarbault, at Orgères, in the department of Eure-et-Loire, France. Suspicious-looking objects were seen on the sun's disc on January 6, 1818, by Mr. Lloft, and in the summer of 1847, by Mr. B. Scott, the Chamberlain of the City of London, but neither of these observations can refer to the new planet, though it is by no means improbable that it is identical with the object seen by Cassini in 1672 and 1686, by Short in 1740, and by Montague in 1761, and by them considered to be a satellite of Venus. M. Le Verrier has computed an approximate set of elements, from which it appears that another passage over the sun's disc will take place sometime during the fifteen days included between March 25 and April 10, and September 28 and October 13, 1860, and also that the period of the planet's revolution round the sun is about twenty days. Further information is anxiously looked for.

STEREOSCOPIC PHENOMENA.—*A Youthful Stereoscopist* offers Mr. Noteworthy the following remarks:—"I have seen some lenses in the shape of the annexed diagram: *a a*, lenses of the stereoscope; *b b*, rays from lenses on the photograph. I think, from the shape of the lenses,



that their rays would cross each other before coming in contact with the picture. Therefore, if a small photograph were placed in the stereoscope, the right-hand lens would cast its ray on the left side of the picture, and the left lens on the right side, and the right side of the photograph would appear to be seen by the left eye, and the left by the right eye."—Another friend explains to Mr. Noteworthy, that "if a person looks long and steadily at a small photographic portrait through a stereoscope, so as to see one-half only with each eye, the two halves will unite correctly, except that the half seen by the left eye is (to me, at least) a little higher than the other. This united picture, which is not clear, especially on one side, requires to attain it a fatiguing effort (like that which many persons experience on first looking through a stereoscope before they attain the stereoscopic effect), but afterwards is at once perceived. The apparent interchange which STEREO saw is perceived only at first."

A CHEAP TELESCOPE.—A really useful telescope may be made by obtaining a single convex lens of four, five, or six feet focus, which lens can be had of an optician for half-a-crown. The tube may be made of paper, of the required length, to suit the focus of the object-glass. Make also two more tubes of tin for an eye-piece, one to slide within the other, the larger one to slide in the tube of the telescope. The annexed diagram will explain what we mean: D is the body; A is the object-glass; B C is the eye-piece. This is somewhat the same telescope as described in a former paper, but with this material difference, a compound eye-piece is used in this one, whilst in the former only a single eye-glass is used. B is a concave lens, and C is plano-convex. By placing B before C, it doubles the power of the eye-piece, and gets rid almost entirely of the prismatic colours, whilst its definition approaches that of an achromatic. This eye-piece can be used as a pancratic. If you pull C out, you must push B nearer to the object-glass. But two or three trials will be the best teacher of what we intend to prove. This telescope will show the satellites of Jupiter, and also the dark belt across the body of the planet. (B, 4 inches, C, 4 inches.)

ENGLISH COPPER COINAGE.—A correspondent asks Mr. Noteworthy about the value of some coins, to which he has thought it best to reply in a note which may interest all readers. The first copper coinage issued in bulk by British sovereigns was that of Charles II., in 1665. It consisted of halfpence and farthings. The farthings had on the reverse the figure of Britannia, with the motto, "Quatuor Maria vindico." On the obverse they had the head of the king, with "Carolus a Carolo." On the edge, done by a newly-invented milling machine, was the motto, "Nummorum famulus," meaning (it is conjectured) the *servant of money*, as being the lowest kind of English money. A farthing of this issue, if as perfect as when *first struck*, that is, "*a fleur de coin*," as they say, may be worth a few *shillings*; if at all rubbed, it is only worth a few *pence*; and if *much* rubbed, it is only worth its weight in copper; those of the same pattern, issued in 1672 (the same devices, except in the motto of Britannia on the reverse), are much more common, and, therefore, worth less. The threepenny, fourpenny, and sixpenny silver pieces of Queen Elizabeth are almost all common, and worth but a trifle more than their intrinsic value in silver. There are a few rarities in the series, but not likely to be picked up in a chance way.

" Sicilian Ætna's blood-red flame was seen
Fitfully flickering."

PHYSICAL EVIDENCES OF THE INTERNAL HEAT OF THE EARTH.

PART I.—VOLCANOES AND EARTHQUAKES.

THE ancients believed in the existence, below the surface of the earth, of vast fiery furnaces, the abode of volcanic agencies, and the place of destination for lost souls. Though the Greeks, in their fables of Typhæus, Tartarus, Pluto, and Vulcan, were indebted to more ancient and more noble philosophies than their own for ideas higher than the Hellenic standard, and though they reduced the cosmogonies of India and Egypt to the low level of their own familiar gods, enough may be seen reflected in their fanciful mythology to show the prevalence, in times of remote antiquity, of a vague notion that the terrestrial globe is the depository of exhaustless fires. This idea is illustrated and established by the latest and most searching investigations of a purely physical kind, and is an addition to the list of instances wherein science has contributed to the confirmation of poetical old-world notions. Perhaps there is no instance so happily illustrative of the close connection between Poetry and Science as this, for assuredly nothing is more boldly poetic than the idea that the solid earth we tread is merely the cool outer shell of a ball

of fluid fire, nor is there any better example of the capabilities of purely inductive philosophy than this inquiry affords us.

When Dr. James Hutton exploded the Wernerian doctrines, he proceeded, by a purely inductive process, not to explain the origin of things, but to elucidate their existing state by the agency of known causes. In addition to the proposition that the stratified rocks are formed of the debris of more ancient structures, he set forth the doctrine that subterranean heat had caused the elevation of continents and mountain-chains, and that the mechanical derangements of the sedimentary strata, as well as the occurrence in them of trap-rocks and metalliferous veins, were due to the same cause, which had been chiefly characterized by wonderful energy and rapidity of action. Wherever granite peaks pierce the heaven with their pinnacles of snow, or wherever sections of the earth's crust are made so as to expose the arrangement of the various layers of which it is composed, we meet with the first links in the chain of evidence that fire was the first agent employed in the structure of the globe. In the first case, we see protruded enormous masses of rock exhibiting no traces of stratification, but many of a former state of fusion. The structure is crystalline and granular; the masses are never arranged in beds, but occur in enormous blocks and irregular masses, and broken by irregular fissures in different directions. Hard as adamant, with no regular cleavage, and so chemically constituted as to set aside all notion of an aqueous origin, these rocks appear before us as "the children of the fire;" the consolidated remains of a past state of incandescent fluidity.

Referring to the arrangements seen in stratified rocks, we always find, when we penetrate deep enough, that these are built on a foundation of granite, while beneath the granite itself, whether it forms the mountain top or bleak escarpment, or underlies many thousand feet of sedimentary strata, no vestige of a stratified rock is ever found. Thus granite, and its associate forms of porphyry and basalt, are reasonably regarded as the most ancient of all formations, the foundations of the world, from the disintegrated elements of which, by the ceaseless action of hurricane and wave and fire, through a succession of illimitable ages, the superincumbent rocks have been formed.

Though every geologist of note now admits that the granitic and trappean masses are the results of simple fusion, and that fire has been the chief agent in their production, some great differences of opinion exist as to whether similar forces are at present in action, whether, indeed, the cyclopean forge still roars and blazes below, or has long since become exhausted, and, by this time, utterly extinguished. Though admitted on all hands that fire has played an important part in the past history of our globe, yet more than one eminent geologist has adopted the opinion that whatever heat may have been embowelled in the earth has long since died out, and that the outbursts of volcanoes, in common with hot springs and earthquakes, are to be attributed not to general but to partial causes, of which chemical affinities are the chief. Let the inductive process guide us where it may in this inquiry, let facts teach us their several lessons, and let our conclusions be based on the evidence which Nature sets before us.

The phenomena which most directly bear on this question are volcanic eruptions, earthquakes, thermal springs, and the peculiar figure of the earth. Each of these offers its own suggestions, and all are equally open to observation, and afford legitimate materials for logical deductions.

Volcanoes are pretty generally distributed over the whole of the world, even more plentifully than is generally supposed. On the continents of the old and new worlds there are about a hundred and ten, while on islands in various oceans there are no less

than two hundred, a hundred and forty being found in the islands of Asia and Oceania alone. In the local sites of these, the first fact which strikes us is their constant proximity to water; those on islands being of course surrounded by the sea, while those on continents are invariably situated on the coasts. Referring to those most generally known, we find Vesuvius adorning the Bay of Naples, Etna presenting its symmetrical cone to the bright waters of Syracuse, Hecla frowning down on rocky bays and regions of "thick-ribbed ice," Stromboli throwing its bright flame day and night over the waves of the Mediterranean, while Cotopaxi and the other Andean craters are on an extensive sea-board.

But volcanoes, though sprinkled diffusely about the world, are nevertheless easily arranged into groups of connection, and of these groups there are three of special note. The first of these is an extensive belt of active and extinct craters stretching from Terra del Fuego, *the land of fire*, along the western coast of South America as far northward as the tropic of Cancer. This belt comprehends the granitic cones of the Chilian ranges, with the ever-burning Villarica in the midst, the three volcanoes of Pasto, the three of Papayan, and the twenty active craters of Guatemala and Nicaragua. Then, turning aside, it embraces Mexico, California, and the West Indies, having here a visible breadth of at least 60°; while, in all probability, it stretches away under the waters of the Pacific as far as 150° of east longitude. Here is an immense series of volcanic vents, extending over a space, from north to south, of more than six thousand miles, and which, running along the western coast of America, turns aside in a serpentine line, and dips under the Pacific westward, and measures again, from east to west, nearly nine thousand miles. This is also a region noted for earthquake violence, for submarine commotions, and for the most tremendous evidences of a great upheaving force. Here, in the chain of the Andes, we find the great Cotopaxi, a perfect cone capped with snow, and of enormous altitude. Etna has a height of 10,873 feet, and Vesuvius 3,932, yet if Vesuvius were piled on Etna there would be wanting 4,073 feet to equal the enormous measurement of this magnificent volcano.

Another definite line of volcanic craters may be traced from Alaska, on the western

The American Group of Volcanic Craters and Regions of Earthquake.

coast of North America, in lat. 55°, across the opening of King William Sound to the coast of Kamtschatka, a distance of ten hundred geographical miles. Along this line earthquakes are frequent, and both sea and land are continually agitated by violent commotions,

which sometimes traverse the whole line in a series of awful vibrations. At the eastern end of this chord are sixteen volcanoes, many of them still active, which keep Cape Lopatka and the Kurile Islands in a state of constant disturbance. The line then trends southwards, and involves the islands of the Japanese group in its convulsive throes of earthquake, and dipping downwards into the fifteenth degree of south latitude embraces

The North-polar Group of Volcanic Craters.

Sumatra, Java, Sumbawa, Papua, the Friendly Islands, and terminates in Tongarira, and the other craters in the northern portion of New Zealand. This extensive chain is represented in the maps in two divisions, because the Aleoutian group has some very distinctive features.

The third belt traverses the south of Europe from the fortieth degree of north latitude to the northern kingdoms of Africa, while, from east to west, it extends from the Caspian to the Azores. Within this region are the classic peaks of Etna, Vesuvius, and Stromboli, each of which still maintains its activity, seemingly exhaustless. Vesuvius and Etna have both recently exhibited proofs that their energies are not yet dead, while the ever-burning Stromboli is a fire-beacon to the Mediterranean Sea.

Let us now connect these volcanic groups into one geographical system, and it will be seen that the earth is belted round with a fiery girdle, the main course of which is from east to west, but which lets fall at least two

The Chain connecting the North-polar Group with the Indian Archipelago and New Zealand.

great ribbons of convulsive power southward. Let it be further noted that the great belt and its related lines all traverse either the sea itself, or coast-lines in proximity to water; for, even where it crosses the old continent, it takes its way by the Caspian, the Black Sea, and

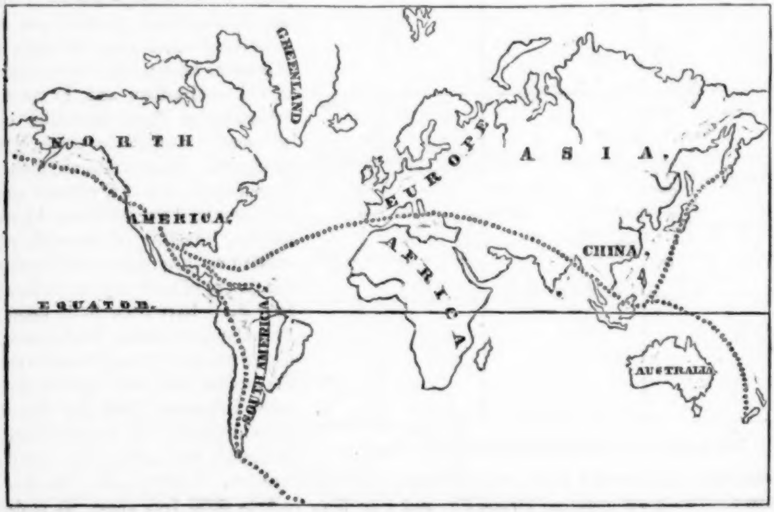
the Mediterranean, and in its course from Japan to the Caspian, through the heart of Southern Asia, there are fewer signs of activity than in any other part of its course. The towering Himalayas serve to connect Pondicherry, which raged violently in 1757, and the "Terribles," where there are two craters together in the Bay of Bengal, with the hills of Thian-Shan, where the last great earthquake occurred in 1832, and the line then passes direct to the southern shore of the Caspian, where

The European Group, from the Caspian to the Azores.

Demavend rejoices in a local fiery renown. Thus the two great opposing forces, Fire and Water, have intimate neighbourship in the superficial projection of the globe, and, as we shall see hereafter, they work together in modelling its hills and valleys, determining the contour of its coast-lines, the dotting of its seas with islands, and the building up of ramparts for the defence of continental lines. If the sea silently, but surely sunders the old landmarks, the fire compensates in an hour for the spoliation of centuries, and thus, according to God's great purposes, the proportions of land and water are maintained in the face of forces which, separately considered, appear sufficient for supreme domination.

Supposing that the combinations of certain chemical ingredients originated these extensive exhibitions of volcanic force, we might reasonably expect to find in the products of combustion a clue to the processes by which they are produced. If the chemist mingles pounded sugar, chlorate of potash, and alchohol, and applies a single drop of sulphuric acid, the compound will immediately take fire. Every tyro can perform similar experiments. But the accomplished chemist can do something more than the tyro in this case; he can take the products of the combustion, and, by an examination of these, determine out of what materials the ashes were produced. The conclusion then is forced upon us, that if volcanic operations were brought about by the meeting together of materials calculated to give rise to combustion, the theory of such explosions would long since have been built upon a firm chemical basis. Such has not been done, for the simple reason that the scoriæ and lava ejected from active volcanoes afford the chemist no evidence of such a special cause. A notable fact is the force exerted in volcanic action. Cotopaxi, in 1738, threw its fiery rockets 3000 feet above its crater, while in 1744 the blazing mass, struggling for an outlet, roared like a furnace, so that its awful voice was heard at a distance of more than six hundred miles. In 1797 the crater of Tunguragua, one of the great peaks of the Andes, flung out torrents of mud, which dammed up rivers, opened new lakes, and in valleys of a thousand feet wide made deposits six hundred feet deep. The stream from Vesuvius, which, in 1737, passed through Torre del Greco, contained 33,600,000 cubic feet of solid matter; and, in 1794, when Torre

del Greco was destroyed a second time, the mass of lava amounted to 45,000,000 cubic feet. In 1669 Etna poured forth a flood which covered eighty-four square miles of surface, and measured nearly 100,000,000 cubic feet. On this occasion the sand and scoriæ formed the Monte Rossi, near Nicolosi, a cone two miles in circumference, and 450 feet high. The stream thrown out by Etna in 1819 was in motion, at the rate of a yard per day, for nine months after the eruption; and it is on record that the lavas of the same mountain, after a terrible eruption, were not thoroughly cooled and consolidated ten years after the event. In the eruption of Vesuvius, A.D. 79, the scoriæ and ashes vomited forth far exceeded the entire bulk of the mountain, while in 1660 Etna disgorged *more than twenty times* its own mass. For such enormous effects correspondingly enormous causes must exist, for which we look in vain to the ashes themselves, or to the construction of the craters from which they are thrown. Vesuvius has thrown its ashes as far as Constantinople, Syria, and Egypt; it hurled stones, eight pounds in weight, to Pompeii, a distance of six miles; while similar masses were tossed up 2000 feet above its summit. Cotopaxi has projected a block 109 cubic yards in volume a distance of nine miles while Sumbawa, in 1815, during the most terrible eruption on record, sent its ashes as far as Java, a distance of 300 miles, while the area affected by the convulsion comprised more than 2000 English square miles of surface; and out of a population of 12,000 souls only twenty-six escaped.



The Principal Lines of Volcanic and Earthquake Phenomena on the Globe.

In viewing these evidences of enormous power, we are forcibly struck with the similarity of action with which they have been associated; and, carrying our investigation a step further, the same similarity of the producing power is hinted at in the identity of the materials ejected. Thus, if we classify the characteristics of all recorded eruptions, we shall find that the phenomena are

all reducible to upheavals of the earth, rumblings and explosions, ejections of carbonic acid, fiery torrents of lava, cinders, and mud, with accompanying thunder and lightning. The last-named phenomena are extrajudicial in character; they are merely the result of the atmospheric disturbance consequent on the escape of great heat from the earth, just as the burning of an American forest causes thunder and rain. The connection that apparently exists, too, between neighbouring craters is strongly confirmed by the fact that in every distinct volcanic locus but *one* crater is usually active at a time. Since Vesuvius has resumed his activity, the numerous volcanic vents on the other side of the bay have sunk into comparative inactivity; for ancient writers, who are silent respecting the former, speak of the mephitic vapours of the Lake Avernus as destructive to animal existence, and in earlier days than these Homer pictures the Phlegrean Fields as the entrance to the infernal regions, placed at the limits of the habitable world, unenlightened by rising or setting sun, and enveloped in eternal gloom.

If this connection be admitted, as we think it must, from the geographical distribution of the Plutonic loci, the *parallel* disposition of all the great granitic groups, the association of volcanic vents in distinct clusters, and the pyrogenous nature of the soil surrounding them, we have to ask what indications do the products of upheaval afford in confirmation of a chemical agency? There is nothing in the felspar, mica, and quartz of the old granite, or in the tuff, puzzola, or pumice of modern volcanoes, to indicate local chemical action, or to show that the combustion of certain materials *inter se* gave rise to the convulsions that ejected them. And yet, when such enormous masses are ejected, sufficient in some places to construct great island-peaks and chains of hills in the sea, and in others to form enormous cones of granite, pumice, and modern lavas, we may reasonably expect to find in the abundance of material some of the traces of their origin.

Various chemical explanations of volcanic energies have been hazarded, and numerous natural affinities of bodies suggested as causes sufficient to produce the effects; but if such wonderful outbreaks of fire and mechanical force are owing to the flowing of water over beds of potassium, or the rapid absorption of oxygen by vast bodies of metals, where are the resultant oxides of these inflammable bases? Where, indeed, the products of any purely inflammatory action brought about by chemical means? Such questions may be asked, and the only answer to be given is, that such resultant products are not to be found. Here, then, we have assigned us a cause which produces no visible effect, for it must be acknowledged, by the warmest defender of the chemical theory, that the sulphur and sulphates, the borax and iron, occasionally found in volcanic disjecta, are so trivial in quantity, compared with the other masses, as to be worthless in support of an hypothesis; nor is it possible to escape the conclusion, that if such products were formed they must come within our occasional observation, either from being cast forth in connected masses, or brought away by the huge torrents of molten rock with which we are so familiar.

The conclusion is therefore inevitable, that to account for the general distribution all over the earth of volcanic vents—to account also for their similarity of action and products—their enormous power and seeming inexhaustibility—their extensiveness of action in their respective sites—the continuance of their energies during countless years, and the incessant burning day and night, from year to year, of such craters as Stromboli; and lastly, though not leastly, the apparent inefficiency of external circumstances in controlling their operations, eruptions happening beneath the sea as beneath the land, in the frigid as in the torrid zone—to account for these and many less striking phenomena, we must seek for

some great and general cause, such only as the hypothesis of the central heat of the earth affords us. That hypothesis supposes the earth to contain within it a mass of heated material; nay, it supposes the earth to be a heated and incandescent body, habitable only because surrounded with a cool crust—the crust being to it a mere shell, within which the vast central fires are securely inclosed. And yet not securely, perhaps, unless such vents existed as those to which we apply the term volcano; and, according to the hypothesis of the central heat of the earth, every volcano is a safety-valve, ready to relieve the pressure from within when that pressure rises to a certain degree of intensity, or permanently serving for the escape of conflagrations, which, if not so provided with escape, might rend the habitable crust to pieces.

Passing to earthquakes, the fact which first strikes us is their intimate connection with volcanoes. Shocks of earthquake usually accompany volcanic fires, and emissions of sulphureous fumes, watery vapour, and even mud, sometimes accompany the occurrence of these convulsions. This was the case in the great earthquake which happened in Sicily, in October, 1835, and which travelled 100 miles in the space of half an hour. In the destruction of Cartago, in Central America, in January, 1842, the centre of the shock was in the midst of a region fruitful in volcanic phenomena, and only three leagues from a constantly active crater. The whole of the West Indian islands are composed of volcanic soil, and constitute a portion of a great volcanic series, and these islands are constantly agitated by the throes of earthquake. The earthquake of Lisbon was one of a series of shocks which disturbed the whole extent of the volcanic region of the south of Europe, and reached even to Africa, every portion of the region affected having its own volcanic centre, active or extinct. Surely chemical causes will not be sought to produce concussions which extend over hundreds of square miles of surface, the extreme points of which are agitated so nearly at the same moment! If electrical agencies were referred to, no doubt many of the conditions required would be fulfilled; but if the interior of the globe is a molten mass of fiery fluid, which occasionally breaks forth and manifests itself at the surface, electrical and magnetic disturbances are to be expected as concomitant phenomena; and these, when once roused into action, as indeed they must be by such extensive and sudden convulsions, would have power to direct, control, and even to impress some of their own characteristics on the general aspect of the convulsion. That they have done so there can be no doubt. For four years preceding the terrible outbreak at Lisbon, the electrical disturbances were marked and frequent; tremors agitated the earth, and many geological changes took place in the arrangements of the strata through the excessive drought, which reduced the conducting power of the soil. Indeed, on the theory of central heat, drought alone, if sufficiently intense, would produce earthquakes when the rains occurred again; for, as the strata differ as to their capacity for water, some would have their conducting power renewed before others, and thus become a sort of insulated conductors. If the electric fluid accumulated in the air sufficiently to discharge itself abundantly to the earth, a succession of shocks would occur. These shocks would reopen the cracks in the earth's crust in a region where many such cracks must abound, water would trickle through from the prevalence of heavy rain; this reaching the incandescent mass below, would generate steam; and then, after the preliminary rumblings caused by the electric fluid, would come the great and terrible explosion, crushing in a few moments the monuments of a thousand years of human toil and enterprise and suffering, and changing cities, hamlets, and fertile fields into frightful deserts, more rapidly than the light of the sun

is obscured by the passing of a cloud or an eclipse.

Here, then, we have an index to the connection between the sea and the volcano, between the occurrence of active volcanic centres and areas of earthquake in the open ocean, or on a general sea-board. The inland volcanoes become extinct simultaneously with the retirement of the sea from their flanks, but the maritime craters are constantly subject to the action of water, which rushes in huge volumes through the fissures below, or creates fissures for itself, and thence giving rise to those explosions, of which mud, water, and steam are the chief products, and to extensive shocks of earthquake in their immediate vicinity.

In all their leading features, earthquakes are identical with volcanic eruptions. The chief distinctions are, that in the latter the action is confined to one fixed spot, while the other travels over vast areas; and while the second are accompanied with the ejection of scoriæ, lava, steam, water, and mud, the first seldom ejects anything but steam, mephitic vapours, and mud, and is rather a violent displacement of certain portions of the earth's surface, than a fiery eruption of fused materials. Still, if we conceive earthquakes to arise from the falling in of portions of the earth's crust in places where cracks and fissures occur, or the splitting of portions into fissures, while volcanoes are direct openings from the atmosphere to the internal fires, we shall at once perceive how such phenomena might be expected to occur in the same localities, and how, while produced by the same general cause, would differ in detail in accordance with the difference of circumstances. The moment that we admit earthquakes to be owing to expansions, contractions, crackings, and upheavals of the crust, consequent on the action of air and water above, and fire below, we have an explanation which removes the difficulty, and places the phenomenon within the pale of inductive reasoning.

SHIRLEY HIBBERD.

AUDUBON, THE ORNITHOLOGIST.

ABOVE the mantel-shelf of a friend I find a rare feather, straight like that of an eagle's wing, and so full of beautiful cloudings and of glorious mixtures of colour, that no eye can dwell upon it without pleasure. The general tone is of a deep Vandyke brown, but in the midst of this beautifully even colour are little round circles of light blue, scattered over as thickly as are the spots on the wings of a Guinea-fowl. These spots are surrounded with small rings of a dusky white, laid on that delicate pencilling which the finger of God alone can lay upon flower or feather; the brown running towards the quill melts into a deeper and more richly red colour, which again gently fades and assimilates into an indigo blue. Examine this feather in any way, the wonderfully light, beautiful material, the elasticity of the fibre, the strength of the quill, the painting of the small plumes, the rich combination of colours, the sweet harmony which it presents to the eye, and no one but could be struck with its beauty. If you take a microscope, you simply reveal new wonders at every step you go. Should you subject it to any test, you would find that a prescient Mind had been before you, had weighed each chance, provided for every accident, and had, with an almighty wisdom, thought out the purpose of the feather, and exactly fitted it to its end. Waive but this feather, and the dreams of the Atheist disappear—the possibility that the

> "Fantastic dance
> Of atoms mixed together in a chance,"

should *make* such will appear a small one

indeed; but that the same "chance" should so beautifully ornament the feather, so that it should so delight the eye which looks upon it, besides having an artistic power which a long education alone can teach us to appreciate, is manifestly absurd. *Chance* might have made it brown, black, or green, of some dun-coloured mixture; without chance it is so beautiful that the most deeply-learned, thoughtful, and skilful artist could not rival it. Observe it even, and it will teach us more. Whatever is wise and good in the writings of M. de Chevreuil, or our own Ruskin, upon the contrast and combination of colour, may be proved by this feather, nay, by a thousand others; it comes from the New World, and the first to reveal its wondrous beauties to Europe was John James Audubon.

When the celebrated Buffon had finished the ornithological portion of his history, it was not unnatural that he should look at it with pride. He believed that he had accurately described every known species of bird. "He announced," says an American writer, "with unhesitating assurance, that he had finished the history of the bird." Twenty centuries had given to the ever-seeking knowledge of man only eight hundred different specimens, but there was one yet to come who would add to the list of the wonderful works of God in this kind nearly half as many more.

Audubon was that man, and his intense devotion to the portion of science which he had determined to explore is so vivid, that it yet throws its light upon the young when daunted by danger, or deterred by difficulty. He was born in Louisiana, in the year 1780, and he died, after a long and useful life, in 1851. He was of French extraction, some say the son of a French admiral, and his parents were Protestant. In his earliest youth he showed an extraordinary passion for natural history. He was always observing some animal, or attending some bird; he could scarcely control it, but in obedience to his father's wish he went to Paris to finish his education, and whilst there studied drawing and painting under the well-known David. After three years he returned to America, and again experienced an ardent desire to devote himself to ornithology.

This passion his father sought to cure in, perhaps, the most effectual way one could imagine. He made his son a present of a magnificent estate in Pennsylvania, and he urged him to marry. Audubon was already in love, and he took the advice; but, says he, naively, "The cares of my household, the tender affection I felt for my wife, and the birth of two children, did not by any means diminish my passion for ornithology. I longed to be wandering in the primæval forests of the American continent; an invincible attraction drew me towards them."

The attraction *was* invincible, and Audubon yielded to it; he left his home and his wife, his children and his estate, and set forth on long and perilous journeys. These he accomplished absolutely alone. Clothed in the leathern dress of the hunter, shod with the moccasin of the Indian, depending upon a few strips of dried venison, or the chance meal which his rifle should bring him, the bold naturalist wandered away from friends and relations; far away from the haunts of man; far and deep into the vast and pathless forests of America; far from the track of the hunter, or the sound of the axe-stroke of the first pioneer; far away into solitudes, where the bear hunted unharmed, or the beaver built his dam across the silvery stream; far away into such deeps that the sun scarce warmed the rich and virgin earth, and the light of the moon scarcely penetrated the black solitudes at night.

Years rolled by, he tells us, whilst he was away upon this passionate study of God's works. The summers came and went, and his wife saw him not. Deep in the woods

was he, afar from noise and turmoil, whilst in the busy cities came rumours of wars; whilst armies engaged, and cannon thundered, and the dead lay on God's earth, their faces to his sky; whilst nation rose or fell, and statesman tricked or minister deceived: of these Audubon knew nothing; silently he followed the narrow path of science; step by step he went on, hunting and tracking, collecting and drawing, and at each step adding another marvel to man's knowledge of that storehouse of all wondrous things, the works of the Creator.

These wanderings commenced in 1810, and continued for fifteen years. Friends, who saw his wonderful collection of drawings, told him of the fame which he would gain when the world saw what he had done, and urged him to publish. But he answered nobly—"It was not a desire of fame or of glory which urged me forward in my long exile; I wished only to enjoy the works of Nature."

He however exhibited many of his drawings to his friends, and to gratify his ornithological devotion, he moved his household to the village of Henderson, on the banks of the Ohio. Called to Philadelphia by the voice of several *savans* who knew his worth, he took with him two hundred of his drawings, representing about a thousand different varieties of birds. Obliged to leave town for some purpose, he deposited these precious drawings, the results of so much toil and labour, with a friend, and was absent for about two months. When he came back, he found that the worst fortune which could happen to him had befallen. Rats had eaten their way through the box in which he kept his paintings, and had destroyed or eaten nearly the whole of them.

"Picture to yourself," cries he, "the pain I felt on seeing this! A sharp and sudden flame seemed to traverse my brain, and I fell into a fever which lasted several weeks. At last moral and physical force seemed to return to me. I again took my gun, my game-bag, my album, and my pencils, and re-plunged into the depths of the forests. It took me three years of hard work to repair the damage those rats had done me."

There is a parallel to this in the story of Sir Isaac Newton and his dog Diamond. It was a little spaniel of the King Charles breed, and used to play with its master. Newton was very fond of it, and continually caressed it, stroking its smooth head as he sat, with his mind occupied with study. One night he left his library, and in it the luckless Diamond, who, jumping on the table, overturned the candle, and set fire to papers upon which were calculations which had cost Newton years. The flame destroyed them all, and the philosopher, on his return to the room, found but ashes. No discovery he ever made renders him greater than the mastery he then showed over himself. "Ah," said he, looking sorrowfully at the dog, "Ah, Diamond, Diamond, little thou knowest the mischief thou hast done."

Audubon was less of a philosopher, but he was every inch a naturalist. The three years thus spent, he says, were "three years of happiness. Each day I went further from the dwellings of man." It took eighteen months more to complete his work, and then, no longer hesitating about publishing, he determined to sail to Europe with his precious drawings. He had met in April, 1824, at Philadelphia, the Prince of Canino, Charles Lucien Bonaparte, who had urged him to publish his works; but America, at that time, could not offer him a sufficiently prominent publishing firm, and hence, after taking leave of his family, he took his passage for England, where he arrived in 1826.

His reception in England was most gratifying. All the *savans* welcomed him. He brought with him four hundred drawings, and these were the theme of general praise. They were shown at Manchester, Liverpool, and Edinburgh, and excited the admiration

of all who saw them, by their evident fidelity and excellent execution. He was received with open arms by all men of letters. Professor Wilson, then editor of "Blackwood," brought him forward as prominently as he could, and thus describes him: "The hearts of all warmed towards Audubon, who were capable of conceiving the difficulties, dangers, and sacrifices that must have been encountered, endured, and overcome, before genius could have embodied these (drawings), the glory of its innumerable triumphs. . . . . . The man himself is just what you would expect from his productions—full of fine enthusiasm and intelligence, most interesting in his looks and manners, a perfect gentleman, and esteemed by all who know him for the simplicity and frankness of his nature. He is the greatest artist in his own walk that ever lived." Cuvier also said that his works "were the most splendid monuments which art had erected in honour of ornithology."

Audubon then set about getting his works into the hands of the engravers. To produce them he found that at least ten or a dozen years were necessary; but neither time nor expense deterred him. He had not one subscriber at first, but his friends of the great Republic of Letters came forward, and in Paris, Cuvier and Humboldt rendered him every assistance. "My heart," he writes, "was nerved, and my energies braced by the reliance on that Power upon whom all must depend." He was not deceived. The Kings of England and France enrolled their names as the first on his list. All the learned Societies took copies, and the great naturalists of each country, especially Humboldt, Cuvier, Swainson, and Wilson, besides Herschel and Scott, were the warmest in the praise of his work.

In 1828 Audubon again went to America, again to explore the vast forests. Not only in the day did he watch, but in the nights also. "Often," says he, speaking of the giant night-owl of America, "when snugly settled under the boughs of my temporary encampment, and preparing to roast a venison steak, or the body of a squirrel, on a wooden spit, have I been disturbed by the exulting bursts of this nightly disturber of the peace that, had it not been for him, would have prevailed round my lonely retreat. He would expose his whole body to the glare of my fire, within a few yards of me. The liveliness of his motions, joined to their oddness, often made me desire to ask him to supper, and made me think his society would be at least as agreeable as that of many of the buffoons we meet with in the world." He also exposes Buffon's mistake as to the dullness of owls, and the "misery" of woodpeckers in the same passage, and says of certain ornithologists, "that to one who has lived long in the woods, they might have seemed to have lived only in their libraries."

In 1830 Audubon came again to England, and towards the end of that year his first volume of the "Birds of America" appeared. It would be useless here to follow the order of publication of his works. Suffice it, therefore, to indicate them. His great work was completed in eighty-seven parts, elephant folio, containing 448 plates of birds of the natural size, beautifully coloured. It was published at the price of £182 14*s*. In America it cost one thousand dollars. It embraced five folio volumes of plates, and five of letterpress, entitled "The American Ornithological Biography." There have been also various new and revised editions of this work.

Audubon also prepared an edition of "The Quadrupeds of North America," 3 vols. double medium folio, 150 plates, and 3 vols. 8vo letterpress. In this latter he was assisted by his sons, Victor Gifford, and John Woodhouse. His style is picturesque, bold, and free; in fact, he tells what he knows, and what he has gained, from studying Nature, and tells it well. His works were chiefly published at Edinburgh.

The great naturalist worked on till he died. After exhausting, as we may say, the birds of America, he, in 1839, turned his attention to the animals; with what result we have shown. He traversed almost every foot of ground in the North American continent. He wrought in his age with the ardour of youth. The publication of the second volume of this valuable addition to natural history, was issued at New York in 1850, less than a month before his death.

His work was done, his long wanderings had ceased, and the time had come when he should be called to his final home. He himself was aware of this. In the almost last letter which he wrote are these words:—"Once more surrounded by all the members of my dear family, enjoying the countenance of numerous friends who have never deserted me, and possessing a competent share of all that can render life agreeable, I look up with gratitude to the Supreme Being, and feel that I am happy."

This was written at the end of 1850—on the 27th of January, 1851, Audubon had ceased to live. HAIN FRISWELL.

DETERMINATION OF LATITUDE.

IT is well known that our earth has a motion from west to east, caused both by its diurnal rotation and annual revolution. It is evident that were the earth a homogeneous sphere, and at rest, the pendulum would describe that line which, if continued, would pass through its centre; in other words, it would fall vertically. But as the earth is neither homogeneous in figure or structure, nor at rest, it is reasonable to suppose that the pendulum does not fall vertically. Its want of uniformity in structure and figure must influence this, while its motion must incline the pendulum in the said direction. It is well known that all bodies have an impulse in the direction of any motion to which they are subjected, whence it follows that the pendulum must not only have this tendency, but have its position altered in consequence. Other bodies may have this influence without their position being affected by it. The luggage in a train, for example, has a tendency to move in the direction of the motion, and would be shot forward with no small force were it suddenly to cease. Friction, or direct prevention, which may perhaps be termed statical pressure, may prevent motion; neither of which, however, materially affect the motion of the pendulum; the friction of the cord and the barrier of the atmosphere, supposing the pendulum not hanging in vacuo, are not obstacles affecting the present consideration. It is remarked by Hunt ("Elementary Physics"), that a falling body has a tendency towards the east, which fact is known to all philosophers; and, although I have never met with the statement, seems impossible not to apply to the pendulum. If this is the case, it is evident that the leaning will increase with the motion, and consequently reach the maximum at the equator. If, therefore, a pendulum were caused to register its position, magnified by accurate and susceptible leverage, it could always be known in what latitude the observer stood, as soon as a scale had been properly graduated, and marked according to observations. The instrument would not be complicated, although great niceness, especially as regards the contraction and expansion of its parts, would be necessary to render it completely effectual. The pendulum, the leverage connected with it, and the scale, are of course its only essential parts. The leverage, if not always necessary, is of course so when the alteration of terrestrial position would be small, in order that the change in the position of the pendulum should by sufficient enlargement be distinctly perceived. It need not be said that an index, or pointer, should be connected with the leverage, and pass over the scale.

J. A. DAVIES.

WAYSIDE WEEDS AND THEIR TEACHINGS.

IN SIX HANDFULS.—HANDFUL III.

" Their heads
Flowers raise, to greet the sun; and man, too, lifts
His thankful soul to God for all these summer gifts."

CALDER CAMPBELL.

The Plants of the Handful—Honeysuckle and Bluebell, Daisy, Thistles, Wild Chamomile, Ragwort, and Colt's-foot—Elder Flower—The Bedstraws—The one-pieced Corolla—Honeysuckle and Composite Blossoms—The Composite Family—Inflorescence—The Scape and Rachis—The Capitulum—The Spike—Axillary Flowers—The Raceme—The Umbel—The Panicle—The Catkin—The Whorl—Glomerulus, Spathe, and Cyme—Bracts.

FIG. 43.—Blossom of Common Wild Chamomile. *a*, disk; *b*, ray; *c*, peduncle. The leaves are divided into capillary or hair-like segments. Inflorescence definite.

WHAT have we? Honeysuckle, certainly, by the scent before we see it, and the "bonny bluebell," and the "wee, modest, crimson-tipped" daisy, that Burns wrote of, and that Chaucer well-nigh worshipped as well as wrote of. These are almost enough to make

FIG. 44.—Blossoms of Common Ragwort. The inflorescence is definite, and arranged in a corymb.

a handful of themselves. But mind your fingers, for there should be prickly thistles

amid our gathering this time, and the great ox-eye, or, as it is called in some places, horse-daisy, and one of those plants which

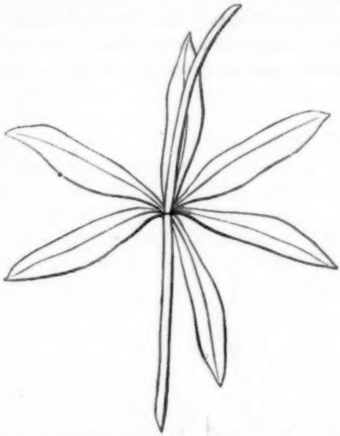


FIG. 45.—Leaves of Common Woodruff, arranged in a Whorl.

children call wild chamomile (Fig. 43), and the yellow ragwort (Fig. 44), with early spring

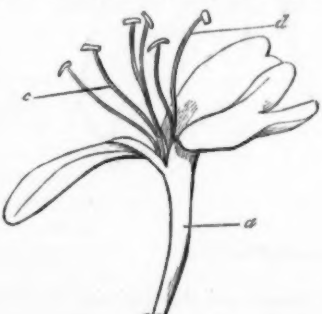


FIG. 46.—Blossom of Common Honeysuckle, in one piece, or monopetalous. *a*, corolla; *b*, calyx; *c*, stamens; *d*, pistil.

colt's-foot, dandelion, and a bunch of elder flowers. We will not pay our readers the bad compliment to suppose they do not know every plant we have just named; probably, too, they can tell the bedstraws and the woodruff, with their leaves placed round their stems in what is called a *whorl*, as shown in Fig. 45. These last do not add much to the appearance of our Handful; but should you chance to cast your plants aside for a few days, you will find that the woodruff has, in withering, developed its sweet, new-mown hay

FIG. 47.—Blossoms of Common Bluebell, or Harebell. The inflorescence is arranged in a panicle. *a a*, leaves of plant; *b b*, bracts.

odour, and still more so if you are pressing it in paper, whilst the other flowers have lost their scent.

You look at the blossoms of the honeysuckle (Fig. 46), the bluebell (Fig. 47), the elder, and, if you have a good magnifier, at those of the bedstraws and woodruff, and you quickly discover that we have left the domain of the many-petaled flowers, and

reached that section where the corolla is all in one piece. (See Fig. 46.) If you attempt to remove it, it must either come away altogether, or it must tear; only you cannot understand why the daisy, the thistle, the ragwort (Fig. 44), and such like plants, find their place here, for truly they seem made up of pieces enough. We will get to them presently.

Now these plants in our hand have one bond of connection with those we gathered into Handful II. They belong to what is called the "Calycifloral" section; in other words, their stamens and corolla are inserted upon the calyx, and not, like the flowers in Handful I., upon the receptacle. Moreover, the plants we are now examining have their corolla and stamens (Figs. 46 and 47) fixed, as it were, on the top of the ovary, as in the case of the true roses and the pome tribe, and also the umbellifers in many-petaled calycifloræ; this being due in all these cases to the calyx growing up as it were around, and thus inclosing the ovary; to speak botanically, being "adnate" to it. The corolla and stamens, however, are just as much inserted into the calyx in these cases as they are in the strawberry and the bramble (Fig. 29A). Thus, then, we have our present section of plants marked off from all others; they are distinct from the many-petaled, and they are no less distinct from

FIG. 48.—Fruit of Common Elder, arranged in a cyme.

their monopetaled brethren, which have corolla and stamens inserted into the receptacle beneath the pistil, pistils, or ovary, like the buttercups and poppies.

Not much is it our honeysuckles do for us in the way of the "utile," but in the "dulce" they are pre-eminent; for what would English hedgerows be in June without their twining woodbines, and what would Scottish braes be in July without their own bluebells, that every summer-straying bairn fills her hand with? How very different from the honeysuckle are the latter (Fig. 47), but yet how akin the parts of likeness for which we have taken them together. Look at one of the flowers from the bunch of elder blossoms, which is so like your old friends of the hemlock or umbellifer tribe; its one-pieced corolla springs from the top of the seed-vessel, which seed-vessel (Fig. 48) albeit will be a black elderberry in September, and its juice, mayhap, form one drop in the cup of hot spiced wine that good housewives delight in. Now, we give you credit for understanding the preceding explanations, but we can see that ever and anon you are puzzling to know what thistles, and daisies, and colt's-foot do here, reminded, perhaps, every now and then, by the prickly remembrances of the former as you grasp your flowers.

Take any one of these last-named plants you like, say the colt's-foot, which will probably greet us first in early spring with its yellow-rayed blossom, and let out farming secrets. However, pull the flower's head to pieces, and what do you find? Not a number of distinct petals, but a numerous company of little flowers, or rather florets (Fig. 49), each with its one little ovary or seed, and the little feathery surroundings which represent the calyx, for bear in mind that the green covering which incloses the buds (Fig. 49, *a*) and holds the expanded flower is not a calyx; but of that more hereafter. Look at your dissected colt's-foot blossom again with your magnifying-lens, or, failing the blossom, at the figure. The first thing that will strike you is, that the little florets in the middle are very different from those at the circumference (Fig. 49, *a*, *c*). The little central flower is as perfect, ay, and as beautiful, a little flower as can be, except that its calyx is not quite after the usual fashion. Its pistil extrudes from its centre (Fig. 49, *e*), and

FIG. 49.—Greatly-magnified View of three Florets of Common Colt's-foot. *a*, tubular floret of disk, with both stamens and pistil, *e*; *b*, bud; *c*, strap-shaped floret of ray, without stamens, but with pistil, *f*, *d*, bracts of involucre; *g*, seed or achene, surrounded by the feathery calyx or pappus, *k*; *h*, common receptacle; *i*, scaly bract.

the little stamens form a tube round it. Botanically, these little central florets are called the florets of the disk, in contradistinction to those at the circumference, which are called the florets of the ray (Fig. 49, *c*). These last, as you at once see, are not regular, symmetrical flowers like those of the disk, but are long and "strap-shaped." Moreover, they have a pistil of their own (Fig. 49, *f*), ovary, and feathery calyx or "pappus," but no stamens, their florets depending for their

fertilization upon the stamens of the disk, as well they may.

Now, this colt's-foot blossom is a most excellent example of this tribe of plants, the Composites, which for all their appearance belied them. Here you see one-pieced blossoms after all, only the blossoms are collected into a close head or *capitulum*, instead of being spread over a stem or peduncle. The part on which the florets are placed (Figs. 49, *h*, and 50, *b*), and which represents the peduncle, is called in these plants the *receptacle;* and the green envelope which represents the leaves of the peduncle, or *bracts*, is called the *involucre* (Figs. 49, *k*, and 51, *b*).

You must not run away with the idea, however, that all our composite heads of flowers are exactly similar to the colt's-foot. In the daisy, in the ragwort (Fig. 44), in the wild chamomile (Fig. 43), you will find

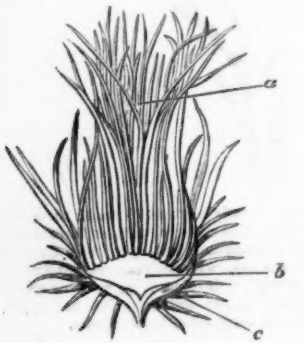


FIG. 50.—Section of Head, or Capitulum, of Common Thistle. *a*, florets; *b*, common receptacle; *c*, bracts, or involucre.

them similar; but not so in the hawkweed (Fig. 51) or in the dandelion, which should not have waited our special mention until now. In the latter, the florets are all strap-shaped, like those of the colt's-foot ray; whilst in the thistle (Fig. 50), and other allied composites, they are all tubular, like those of the colt's-foot disk.

It will be an excellent lesson and exercise for you to gather these composite blossoms and examine them. You must expect, in doing so, to find considerable variation in the distribution of the stamens and pistils in the tiny florets. The composites form such an extensive family, that botanists are fain to divide them, according to these floret distinctions, into tribes, whereof the lettuces, dandelion, hawkweed, etc., belong to one, the thistles and burdocks to another, the daisy, ragwort, colt's-foot, and many another to the third.

FIG. 51.—Back View of Blossom of Common Hawkweed. *a*, strap-shaped florets of ray; *b*, bracts, constituting the common involucre; *c*, peduncle; *d*, scale.

We have already alluded to the peculiar form which the calyx—not the involucre, remember—assumes in the composite family; feathery in a greater or less degree, as familiar to us all in thistle-down, and in the dandelion parachute, and botanically called the pappus. It remains after the floret has withered and fallen off, and until the ripened seed calls for its aid to transport it far from the parent plant. Something more of this aërial seed-sowing shall we learn when we come to examine our fruit-basket. It is not all composites, however, which have these

feathery wings; the daisy, the chamomile, the chrysanthemum, and others, have none, or at best a few tiny scales, to show where they should be.

Both in the way of food and medicine, the composites, of which we have examined these few representatives, yield largely to man. The prevailing principle is a bitter, sometimes, as in the wormwood, aromatic, or, as in the lettuce, narcotic to an extent which makes itself known even in the cultivated vegetables, and is strong in some of the uncultivated species. Dahlias, aster, cinerarias, purple groundsel, the everlastings, are a few of the many brilliant flowers this great family offers to us.

The elder, which we lately mentioned, belongs to the same tribe as the honeysuckle, whilst the woodruff and bedstraws represent to us the madders, their most remarkable features being the "whorled" disposition of the leaves around the stem (Fig. 45). The bedstraws have some of them white, others have yellow flowers; the flowers of the woodruff are small, but brilliant white, and those of the little field-madder are pink. Tiny corollas are they all, but elegantly cruciform in shape. If you have the patience to dissect them, under your lens you will find the stamens fixed to the corolla, and the corolla to the calyx. No lens do you need, however, to look at the bluebells, the representatives of the campanula tribe, and you easily make out that the same floral structure which has grouped our Handful prevails with them; the stamens, however, are not attached to the corolla, and the stigma is lobed.

SPENCER THOMSON, M.D.

(*To be continued.*)

THE ANATOMY OF A CUBE.

IF a solid block of wood, of the form represented in Fig. 1, were given to any person

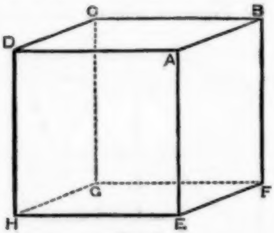


FIG. 1.

not accustomed to look a little below the surface of those things which present themselves to the eye; and he were asked to dissect it, to describe its anatomy, its structure, its most interesting relations to other forms, to show the facility with which more complicated figures, such as Figs. 2 and 3, could be cut out of it, and to point out the extreme value of such knowledge to all who are en-

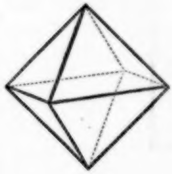


FIG. 2.

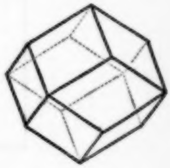


FIG. 3.

gaged in pursuits dealing with solid materials; he would perhaps smile incredulously, and tell you that it was simply a block of wood, square every way, and that he did not see anything more in it, or that anything more could be said about it.

Let me, to use the exquisite simile of one of our greatest poets, endeavour, "to strip the veil of familiarity from his eyes, and lay

bare those hidden and concealed beauties which are the spirits of its form."

To follow with advantage the description of the anatomy of the cube, it will be necessary for the reader to provide himself with the means of reproducing the forms described. Fortunately the modes of illustration are equally accessible and economical.

A bar of hard, firm soap cut into equal-sided blocks; or, failing these, a few cubes cut out of some good-sized turnips, or even potatoes (although the latter are rather small for our purpose); several pieces of thin straight wire—slender knitting-needles answer very well—and some pieces of card, or pasteboard, furnish all the requisites.

Before proceeding any further, let the reader draw, upon a sheet of cardboard, six squares, arranged as in the annexed figure (Fig. 4), but much larger in size. Let him

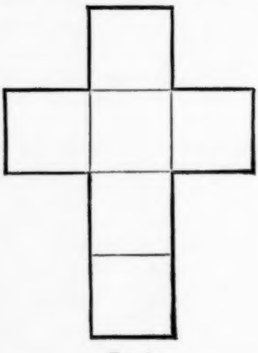


Fig. 4.

now, with a sharp-pointed knife, cut quite through the dark external lines, and half through the light ones, when the cardboard can be readily folded up into the form of a cube, of which it is in fact the envelope.

Availing ourselves of any one of these cubes, let us proceed to examine its external structure before we investigate its internal anatomy. A cube is not, as it is often ignorantly termed, a square, but a solid figure bounded by *six* equal square faces, and hence often termed by geometers the hexahedron. Each face has four right angles, consequently there are twenty-four such angles in the whole. It has twelve edges or boundary lines of equal length, each one formed by the meeting of two faces. It possesses eight corners, or, as they are more correctly termed, *solid angles*, each formed by the meeting of three faces.

The cube is, in fact, one of those remarkable solid forms (of which only five exist) in which all the parts are equal. Its faces, its angles, its edges, its solid angles, are uniform. Hence it is said to be one of the five regular solids; or, as they were termed by the ancients, the Platonic bodies—which were believed by them to possess mysterious properties on which the explanation of the most secret phenomena of Nature depended.

Let us now consider what are the longest straight or right lines that we can draw upon the faces of the cube. It is evident, upon the first trial, that such lines are those which run through the opposite angles of each face; hence they are termed diagonals, from δια through, and γωνια an angle. If we draw all the diagonals on the faces of the cube, as represented by Fig. 5, it will be seen that they

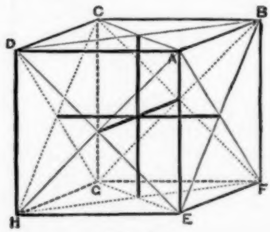


Fig. 5.

cross or intersect one another at the centre of each face. Let us now imagine lines passing from the centre of each face to the centre of the opposite face; it is obvious that these lines will pass through the centre of the solid;

that there will be three of them; that they will be of equal length; and that each one will be at right angles to the other two. To render all this perfectly evident, let a cube of soap or turnip be taken, the diagonals drawn on its faces, and the wires inserted through it to show the position of these internal lines, or *axes*, as they are usually termed.

Suppose the query to be asked, What is the longest line that can be placed within a cube? Take the hollow envelope, and opening one face as a sort of lid, make the experiment with a wire; it will be found that the longest line which can be placed within a cube, is that passing from one solid angle to the opposite solid angle. Furthermore, that there are four such longest lines, and that they cross or intersect each other at the centre (see Fig. 6); hence

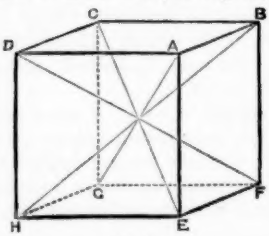


FIG. 6.

they also constitute a second series of *axes*. And lastly, a third series of axes may exist, passing from the centre of edge to the centre of opposite edge, as shown in Fig. 7. Of

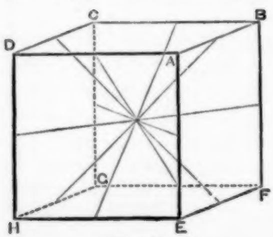


FIG. 7.

these there are necessarily six, being half the number of edges.

Before going any further with the study of this solid, it will be desirable that the student should possess the power of delineating it with its axes, and sections, and also the other solids which may be contained within it, as shown in Fig. 8. For this pur-

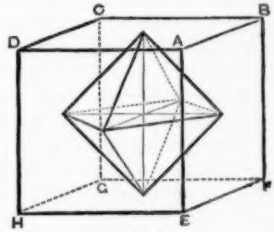


FIG. 8.

pose draw a square of the size required (Fig. 1, D, A, E, H); from D draw the line to C, at an angle of thirty degrees with the line D, A; then from the angles A, E, and H, draw other lines perfectly parallel to D, C. Make each of them half the length of the sides of the square, and then join C and B, B and F, F and G, G and C, and the figure is completed. To draw the three regular axes, the diagonals of the faces should be drawn and the axes made to connect their intersections (see Fig. 5). It is highly desirable that these isometrical drawings of the cube be made; they tend greatly to render the forms familiar to the student, and if the axes and lines of construction are put in in different colours from those which represent the edges of the solid, the figures become more distinct, and may be made to form very pleasing, because symmetrical, drawings.

Suppose a cubical block of stone be given to a workman, out of which he is desired to cut the largest slab that he possibly can. It is obvious that he must cut it diagonally across two faces, and through two edges; as, for example, through the lines D B, B F, F H, and H D (Fig. 5). In this way he would get a plane section, the form of which would be

an oblong or right-angled parallelogram. Let us consider how many such sections can be made in a cube. A little consideration will show that such a section can be made in six different ways. If this be not quite clear, let the student have recourse to the hollow cube, formed of the folded envelope, and place a piece of cardboard, cut to the proper size and shape, in the position of each section successively.

Let the diagonals of these parallelograms be drawn on the piece of cardboard; when, if again placed in the hollow cube, it will be seen that these diagonals of the section are the longest lines that can be drawn within the cube, and that they correspond to the second series of axes (Fig. 6).

As there are *six* diagonal sections of the cube, and two diagonal lines to each section, it would appear that there should be twelve such lines; whereas, by referring to Fig. 6, it is obvious that there can be but four—an apparent deception, which depends on each line being common to three of the sections. Possibly my readers are beginning to see that there is more in a cube than a mere square block.

Having spoken of the sections of the cube made by cutting through two of its faces and two edges, let us now proceed to consider the sections that would be obtained by cutting through three faces, or, in plain terms, by cutting off a solid angle. The simplest experiment with a cube of soap will at once prove the section to be a triangle, and that it may be so varied by cutting through the three faces equally, or unequally, as either to have its three sides equal, two only equal, or all three unequal, and thus to produce an equilateral, isosceles, or scalene triangle. The largest section of this kind that can be obtained is formed by cutting through the diagonals of the three adjacent faces, as from D to B, B to C, E to D (Fig. 5).

The sections obtained by cutting through four faces of the cube are very various. If the section is made parallel to any of the faces, it is a square equal to the faces. A very interesting section is obtained by cutting from one solid angle to the opposite, as from B to H. If this is made equally through the four faces, it cuts the edges A E and C G across at the middle of each, and the section is a rhomb, or diamond, the long diagonal of which corresponds to one of the longest axes of the cube (Fig. 8), and the shorter to one of those represented in Fig. 7. Let the student endeavour to discover how many such sections can be made in a cube, and the number will probably surprise him.

A plane section made through five faces of the cube, will, of necessity, have five edges, one corresponding to each face cut through, and will therefore be a five-sided plane figure, or pentagon; but as it is impossible to cut equally through five faces, the regular, or equal-sided, pentagon is never produced.

If a cube of soap, or other soft solid, were given to a person, and he were asked whether, with one straight cut of a knife he could cut through all the six faces, he would in all probability state that feat to be impos-

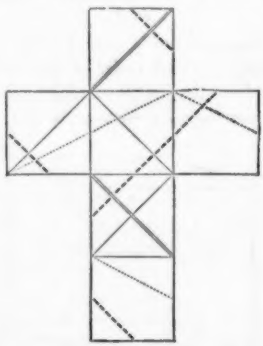


FIG. 9.

sible; yet, in reality, nothing is more easy. To demonstrate this fact, let the student draw a cube, as Fig. 1, and place a dot at the mid-

dle of each of the following lines, A B, B C, C G, A E, H G, and H E. If he will then connect these points by lines passing along the faces of the cube, he will delineate, in perspective, a regular hexagon. This he can show by cutting a cube of soap in a corresponding manner. It is most desirable that the student in geometry, or in isometrical perspective, as well as the artificer who has to deal with the *conversion* of materials, should have an accurate conception of these several sections of the cube, and he should, therefore, adopt every mode of illustrating them. One of the most desirable plans is to draw the lines of the sections on the envelope of a cube, as shown in Fig 9, where the double lines represent the section through two faces; the single diagonal lines show one of the largest sections through three faces; the fine dotted lines the rhombic section through four faces; and the coarser dotted lines the hexagonal section through all the faces. The student is strongly recommended to draw these several sections on separate envelopes of cubes, so that, when each is folded up, the position of the sections shall be evident.

Having now gone through a few of the properties, and some of the more interesting sections of the cube, and having exhausted the space devoted to the subject, we must necessarily defer the consideration of the beautiful solid forms which are contained within it, to our next paper on the subject, concluding our remarks by strongly recommending our readers to follow the descriptions, by the aid of the simple appliances indicated in this paper.

W. B. TEGETMEIER.

THE ELECTROTYPE.

UNWIELDY as is the apparatus used by the professional electrotypist, and numerous as are the articles which he has occasionally to employ, it is nevertheless quite possible to make many very interesting experiments as a means of recreation, and to produce objects of ornament and utility, by the aid of apparatus of the most simple and inexpensive character.

Knowing, as we do, that many are deterred from attempting the practice of this interesting art, by the idea that its processes are costly, uncertain, and difficult, it has occurred to us that an account of some experiments which we have lately had occasion to make with apparatus of the very simplest kind, would not be unacceptable to those who find their recreation in the pursuits of science. Our special object was to reproduce fac-similes of a series of coins; but as the description of the process employed upon one equally serves for all, we will confine our attention to one coin only, and, for the sake of our readers, we will speak of a coin accessible to all, rather than some rare one, which possibly they may have never seen.

Let us suppose, then, that we have before us a florin—it would be well to select one that is not too much abraded or worn—and that we wish to produce a fac-simile of the side containing the royal profile in copper. The first thing to be done is to prepare a mould, that is, a counterpart, in lead,* of the coin to be copied. To do this, take any small vessel of earthenware, as a tea-cup, and press a piece of writing-paper into the bottom, so as to form a kind of rough lining to the vessel.

* Better than lead would be the metal called *fusible alloy*, which may be made by mixing intimately 8 oz. of bismuth, 5 oz. of lead, and 3 oz. of tin. This alloy melts readily at a temperature rather lower than that of boiling water. It may be purchased ready prepared.

Into the cup, thus prepared, pour a small quantity of melted lead; remove the film of oxide, which immediately forms on its surface, by means of a slip of paper, and, just before it is cool enough to set, drop upon it the florin, profile downwards. Owing to the lesser specific gravity of the silver, it will float, about half immersed, upon the surface of the lead. In a minute or two, the contents of the cup may be turned out, a process greatly facilitated by the paper lining, as, without this, the metal might stick to the earthenware, and possibly break it. If, on examination, the impression is found to be imperfect, from the presence of air-bubbles, or from the intrusion of any foreign substance, the metal must be remelted, and the process repeated. If, however, it be found perfect, we may proceed.

Let A A (Fig. 1) represent the mould thus produced; the wire (C C) should now be

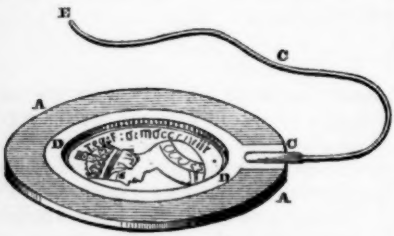


FIG. 1.

fixed to it, either by means of a drop of solder, or, if a soldering-bit be not at hand, by means of sealing-wax. In the latter case, take particular care to clean the surfaces which come in contact both of the lead and copper-wire, by rubbing them with sand-paper. If, however, the fusible alloy mentioned in the preceding foot-note be used, a far preferable way of attaching the wire would be thus:—Clean the end of the wire with sand-paper, hold it in the flame of a candle, so as to leave a quarter of an inch of the end unblackened, while the portion immersed in the flame becomes red hot. Now touch the clean end with a little powdered rosin, and instantly apply it to the mould (at C) with a gentle pressure. The metal will readily yield, and the wire will become firmly embedded into it without further trouble.

On account of the facility with which fusible metal is thus operated upon, and the low temperature at which it melts, it will generally be worth the amateur's while to procure this alloy at starting. Nevertheless, just for a first trial of one's hand at electrotyping, lead will do very well.

But it is not desirable to deposit the copper upon the entire surface of the mould thus prepared; and, in order to confine the deposition to the impression, it becomes necessary to cover the remaining portion with some nonconducting material.

For this purpose, tallow or wax may be used. It should be melted and rubbed over the mould, so as to cover every portion, except the central depression, and a narrow rim round it, as shown at D D (Fig. 1); in doing which, exercise the utmost care to prevent the impression from being soiled, or even touched by the fingers, for on the fulfilment of this condition will the success of the experiment greatly depend. The mould being thus prepared, we may turn our attention to the construction of the voltaic apparatus, and the cell for deposition.

At the end E of the wire (Fig. 1), a plate of zinc, about three inches long and an inch and a half wide, is now to be attached. It will be sufficient to punch a small hole in one end of the plate, to clean that end with a piece of sand-paper, and also the end of the copper-wire, and then to run the latter through the hole in the plate, and secure it by tightly twisting. This process of cleaning should be carefully observed, in order to insure a perfect contact between the two metals. Now for the cell.

A stoneware jar, of from a pint to a quart capacity, will do very well for coins and me-

dallions of moderate size. The form Fig. 2 is most easily obtained, but the form Fig. 3) is rather more convenient, as the open

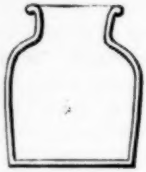


Fig. 2.

Fig. 3.

mouth renders the interior more ready of access, and offers greater facilities for observation. Suppose one of the latter obtained, a piece of wood should now be fixed across it by simple pressure, as at A (Fig. 4); the jar may then be filled to within an inch of the top with a saturated solution of sulphate of copper, and a few additional crystals may then be thrown in, to keep up the strength of the liquid as copper is deposited on the mould. Now prepare a small bladder, or portion of a larger one, of sufficient size to cover the zinc-plate loosely. Make a mixture of one part sulphuric acid and five parts water; fill the membranous bag with it, and tie it over the zinc-plate, giving the whole of this part of the apparatus the form shown in Fig. 5. It may then be applied to the deposition cell in such a way that it shall rest on the beam (A, Fig. 4) by the wire (W, Fig. 5), the coin hanging on one side, and the covered zinc-plate on the other. Both ought to be completely immersed in the solution of sulphate of copper. If this part of the business is carefully managed, and the mould is not put into the solution till all is quite ready, according to the instructions above given, the surface will be instantaneously covered with a thin film of copper, which will gradually increase in thickness and tenacity for some hours. After about four-and-twenty or thirty hours, the mould may be removed from the cell, and the copper from the mould, when all the lines and impressions of the original coin will be faithfully reproduced in the copy.

Fig. 4.

Fig. 5.

If, however, the copper has not been deposited on the mould, or has only been deposited in part—and it is only fair to admit the possibility of such a catastrophe at a first attempt—the error must be sought out and rectified. If *no copper* has been deposited, it may probably be owing to the fact that the connection between the wire and the zinc, or between the wire and the mould, was imperfect; and the mode of correcting this error is obvious. If copper is found to cover *a part* of the mould, and not other parts, it is most probably owing to the presence of dirt or some foreign matter on the surface of the mould. In this case the deposited copper should be removed, and the mould thoroughly cleaned; after which the process as above detailed can be repeated. Should the mould be found well covered, but copper covering crumble to pieces on being removed, the acid was most likely too strong, and must be more diluted in the next attempt. If the young experimenter will attend to these details, we think it is scarcely possible for him to fail at last. *Perseverantia omnia vincit.*

It is hardly worth while to attempt an explanation of these decompositions and depositions in a philosophical manner. In truth, the whole matter is very imperfectly under-

stood.* Whether electricity is to be regarded as a material principle, and whether it combines with other elements as the elements do amongst themselves, has yet to be decided. It will be sufficient to notice here, that whenever two metals are placed in a liquid which acts unequally upon them chemically, the electric equilibrium is disturbed. Positive electricity comes off from the metal acted upon most vigorously, while the metal itself becomes negatively electrified. The fluid then passes to the metal less acted on, and from that through the connecting wire above, till it reaches the former metal, and thus the electric circuit is completed. In such an arrangement—the chemical liquid containing a metallic salt—the metal would always be deposited on the plate which was least acted upon by the liquid; but the deposition is irregular and uncertain. It is much improved by immersing the negative metal in a different liquid, and separating this liquid from the solution by means of a membrane, as described above. This, however, is not a convenient arrangement where a number of experiments are to be made in succession, although it does very well for a solitary attempt. We will, therefore, conclude this paper by describing one or two modifications of this "*single-cell*" apparatus, as it is called, which add greatly to its efficiency.

The membranous diaphragm with which we have supposed the zinc-plate to be covered is not effective in experiments which last any time. Porous jars, such as may now be obtained at any chemist's, are used instead. They are cheap, and can be used repeatedly, especially if, when they are done with, they are laid for a few hours in clean water. If, however, a chemist's shop be not easily accessible, the following way of making very good porous diaphragms will be found useful:—

Let a core be turned out of a piece of hard wood, of the shape A A (Fig. 6). Bind round this core a piece of smooth brown paper, B B, in such a way as to leave a clear space round the smaller part. The space thus left is now to be filled with plaster of Paris, which must be added till it reaches the height C. The plaster is thus prepared:— Take it quite fresh, and drop it piece by piece into a lipped jug containing water; when it is dissolved, the superfluous water may be poured off. Mix the remaining water and plaster with a clean stick, and pour it into the mould. When it is firmly set, the paper may be unwound, and the core withdrawn; a porous diaphragm will thus be formed, which, with proper care, will serve for several experiments.

FIG. 6.

A better form of cell, too, might be easily devised. A wooden box, lined with pitch or well varnished, and furnished with a shelf to hold the crystals of sulphate of copper, the shelf also having an orifice to receive the porous diaphragm, would be found more convenient. Such an apparatus, when at work, would have the form shown in Fig. 7.

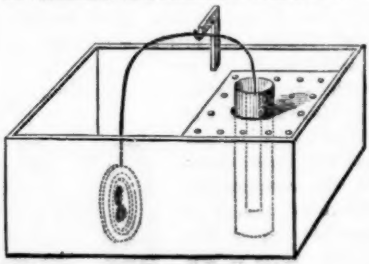


FIG. 7.

* To those who are curious on this subject, we recommend a perusal of a work which has come to our hand, entitled "Electro-Chemistry, with Positive Results; in which it is demonstrated that there is a latent electricity in bodies as well as a latent heat, and that those bodies, when deprived of their latent electricity, indicate a change in their characteristic properties. By Charles Chalmers. Churchill, Burlington Street." We may have occasion to refer to this work again.

Attempts have sometimes been made to join the fac-similes of the two sides of a coin, so as to give them a solid appearance, like the original. These attempts have not succeeded well, and, what is more to the point, they would not be so useful thus finished as when mounted in a different manner. For cabinets, it is better to have the fac-similes so mounted as that both may be seen at a glance. The superfluous rim, which is given to the specimens we have described, is of great service in this respect.

Take a card, and draw upon it two series of concentric circles (Fig. 8), the inner ones of which are just large enough to admit a florin, or its fac-simile, when the card is cut away for that purpose. Into these orifices insert the fac-similes, and press the rims close up to the under side of the card. Then take another card, and gum it to the under side of the first, in order to keep the fac-similes from dropping out of their places. They are then ready for the cabinet, and will present an appearance similar to that in Fig. 8, the concentric circles giving the mounting a finish which well repays the trouble bestowed upon them.

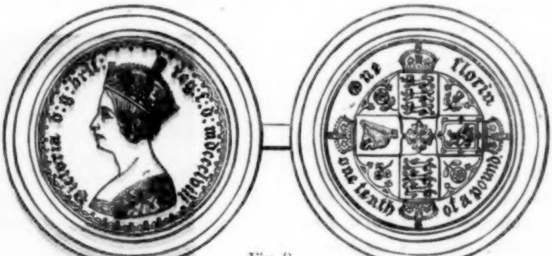


Fig. 8.

R. Bithell.

THE LUNAR ECLIPSE OF FEBRUARY 7, 1860.

—o—

Although an eclipse of the moon falls far short of a solar eclipse in astronomical importance, it yet possesses an interest of its own, from the varying appearances exhibited by our eclipsed satellite, and also from the picturesque effect produced, as the writer can testify after witnessing the phenomenon of February 7th.

The physical peculiarity which has attracted the attention of astronomers during a lunar eclipse, is that ruddy hue by means of which the moon is rendered visible even when totally immersed in the earth's shadow. The cause of this phenomenon long remained unknown; by some persons it was attributed to a supposed inherent light in the moon's surface, but it seemed impossible to reconcile this explanation with the appearance of the moon in other parts of her orbit. The great Kepler solved the difficulty; he was the first to show that this phenomenon was occasioned by the *refraction of the earth's atmosphere.*

Let not the reader pass lightly over this sentence, with the remark, "It is caused by refraction." The subject is curious and interesting, and the words of Kepler were weighty. He expresses his explanation in this way:—"The sun's rays are inflected in their passage through the earth's atmosphere, and thrown *into the cone of shadow.*" That

"cone of shadow" must engage our thoughts for a few minutes—the cone of darkness (turned exactly away from the sun), which evermore accompanies the earth, and which the moon occasionally enters, either completely or in part, when her varying path conducts her sufficiently near to being in a straight line with the earth and sun.

Fig. 1.

Fig. 1 represents the leading circumstances connected with the shadow; its conical shape is due to the superior size of the sun as compared with the earth. When a large luminous body (for instance, the sun) illuminates a small opaque one (as the earth), the latter must cast a conical shadow. The round form of the *section* of this cone, as viewed when its rim is projected on the moon during the progress of an eclipse (see Figs. 2, 3, and 4), is a visible demonstration of the earth's round shape. It is a portion of the earth's *silhouette*. To return to the figure: E represents the

Fig. 2.—1h. 58m., Greenwich time.

earth, one side basking in sunshine, the other casting the usual conical shadow, in which the moon, M, has entered centrally, thus undergoing total eclipse. The faintly shaded portion, *a a*, represents the region adjoining the shadow, from which a portion of the sun's disc is hidden by the earth's body, thereby causing a partial shadow, or "penumbra." The moon always travels a considerable time through the penumbra before passing into the true shadow.

So far this explanation corresponds with that contained in all works on astronomy; but we now come to the consideration of some circumstances due to the presence of the

Fig. 3.—2h. 20m., Greenwich time.

earth's atmosphere. Not the portion of atmosphere which intervenes between ourselves and the eclipsed moon, but that portion which surrounds this great earth's *outline*, as viewed from the moon. Imagine a special ray from the sun, *d*, *e*, passing through the atmosphere to the surface of the earth; the

Fig. 4.—2h. 50m., Greenwich time.

presence of that atmosphere will alter its direction—*will make it bend*, as you have seen an oar appear to do when plunged obliquely in water. On proceeding from *e*, through the remainder of the atmosphere, the ray becomes additionally bent, and in the same direction; the consequence is, that it will

enter the cone *b b*, instead of passing on to the apex *f*.

Thus a considerable portion of the cone of the earth's shadow will receive this refracted light of the sun; and this light will have a reddish tinge, because it does not reach the moon till after passing through a very great thickness of the earth's atmosphere; and under such circumstances it is found that the air will stop the blue and violet rays which enter into the composition of white light, and will transmit the red, an effect corresponding to the ruddy colour of the sky at sunset.

There will, however, remain a smaller cone, *e*, of real darkness, which even the refracted light will not enter; but the apex of this latter cone is situated within the moon's shortest distance from the earth, so that the moon never gets into the cone of true darkness. This being the case, the wonder is, not that the moon should remain visible during a total eclipse, but that it should ever completely disappear. It is, however, particularly recorded to have become invisible during total lunar eclipses in 1601, 1620, 1642, 1761, and, in more recent times, on the 10th of June, 1816, when it could not be discovered even with telescopes; yet on some of these occasions, especially in the case of the eclipse of April 25th, 1642, the air intervening between the moon and the observer was particularly pure, and minute stars could be discerned.

On the other hand, the moon has sometimes shown, during a total eclipse, with an almost unaccountable distinctness. On December 22nd, 1703, the moon, when totally immersed in the earth's shadow, was visible at Avignon by a ruddy light of such brilliancy, that one might have imagined her body to be transparent, and to be enlightened from behind; and on March 19th, 1848, it is stated that so bright was the moon's surface during its total immersion, that many persons could not be persuaded that it was eclipsed. Mr. Forster, of Bruges, states, in an account of that eclipse, that the light and dark places on the moon's surface *could be almost as well made out as in an ordinary dull moonlight night.*

Sometimes, in a total lunar eclipse, the moon will appear quite obscure in some parts of its surface, and in other parts will exhibit a high degree of illumination. All these varying appearances, it is concluded, are to be referred to the condition of that zone of the earth's atmosphere through which the rays pass from the sun into the cone of shadow. To a certain extent, I witnessed some of these phenomena during the merely partial eclipse of February 7th; and though I cannot find any published account of remarkable phenomena observable during a *partial eclipse*, I maintain that the one I witnessed deserves to occupy a very high place, if judged of with regard to its picturesque effect.

I will therefore briefly narrate what I saw. First, however, let me state that for the foregoing explanations and descriptions of phenomena, I am indebted to the valuable works mentioned below,* and in four or five sentences I have used their exact words. I had some idea of borrowing merely the ideas, and altering any sentence which I did not indicate with quotation marks. But the change would have been for the worse, and the process similar to that indicated by *Sir Fretful Plagiary*, whom, by the way, I quote at second-hand, from a writer who is as much the antithesis of Sheridan as his work is of the *Critic*:—"Steal! to be sure he may, and serve your best thoughts as the gipsies do stolen children—disfigure them to make them pass for their own."

I prepared, during the afternoon of February 6th, for witnessing the eclipse, without any distinct expectation of seeing much

* Nichol's "Cyclopædia of the Physical Sciences;" Grant's "History of Physical Astronomy;" Humboldt's "Cosmos;" Mann's "Guide to the Knowledge of the Heavens."

worthy of note. I knew, however, that upwards of eight-tenths of the disc would be covered, and I was anxious to observe with what degree of distinctness the eclipsed portion could be viewed, partly as an interesting fact, and partly with a view of verifying or

Lunar Eclipse: 2h. 20m. a.m., Feb. 7th, 1860

discovering the weak points of an engraving (in which I am concerned) of a lunar eclipse.

After seeing the increasing darkness of the penumbra softly merging into the true shadow at the commencement of the eclipse (about one o'clock, a.m., Greenwich time), I proceeded with pencil and paper, dimly lighted by a distant lamp, to note by name the different lunar mountains and plains (the so-called seas), over which the shadow passed; and also a few other circumstances, such as the great clearness of the planet Saturn, and the colours of the halo round the moon, when light clouds passed across its disc. During the first hour and ten minutes I had seen nothing unexpected; but had much enjoyed the time when the sensation of quiet and calm is so soothing, and in itself such matter for thankfulness; and when the mind turns to think on Him "who hath created all these things," and to feel with especial distinctness on an occasion like this, when a phenomenon occurs so truly to its appointed time, "He is strong in power; *not one faileth*."

I had repeatedly written down my observations of the remarkable clearness with which the moon's eclipsed outline could be seen, both with the naked eye, and with the telescope; at 1h. 58m., however, I suddenly noted the ruddy colour of a portion of the moon. I may as well give my notes in the original words, as copied next day in a more connected form:—" 1h. 58m. (Greenwich time).—I am suddenly struck by the fact that the whole of the western seas of the moon are showing through the shadow with singular sharpness, and that the whole region where they lie has assumed a decidedly reddish tinge, attaining its greatest brightness at a sort of temporary *polar region*, having 'Endymion' about the position of its imaginary pole. I particularly notice that the Lake of Sleep has disappeared in this brightness, instead of standing out in a darker shade; and I notice that this so-called *polar region* is not parallel with the rim of the shadow, but rather west of it. 2h. 15m.—Some clouds, though very thin and transparent, now intervene. 2h. 20m.—The sky is now cleared. How extraordinary is the appearance of the moon! *Reddish* is not the word to express it; it is red—red-hot! I endeavour to think of various red objects with which to compare it, and nothing seems so like as *a red-hot*

penny—a red-hot penny with a little *white*-hot piece at its lower edge, standing out against a dark-blue background; only it is evidently not a mere disc, but beautifully rounded by shading.

"Such is its appearance with the naked eye; with the telescope its surface varies more in tint than with the naked eye, and is not of quite so bright a red as when thus viewed. The redness continues to be most perceptible at a distance from the shadow's southern edge, and to be greatest about the region of Endymion. The Hercynian mountains (north of Grimaldus) are, however, of rather a bright red, and Grimaldus shows well. Mare Crisium and the western seas are wonderfully distinct. Not a trace is to be seen of Aristarchus or Plato. 2h. 27m.—It is now nearly the middle of the eclipse. The red colour is very brilliant to the naked eye; yet when the moon is viewed through a pin-hole in paper the red portion nearly disappears, and the small bright piece looks wonderfully minute and sharp. Through the same pin-hole Jupiter (which is truly splendid to-night) becomes no brighter than Castor."

The planets and stars were indeed glorious on that night; Saturn and Regulus were east of the Moon, and very near it, while Jupiter and the conspicuous stars of Gemini glittered at no great distance in the west. They were in themselves most beautiful, and with the red and white moon, and the dark blue sky—a unique assemblage of the hues of the tricolor—the effect was picturesque in no common degree,* while trees and mountains were not wanting to complete the terrestrial landscape.

After this, I noticed a progressive change of tint in the moon. "2h. 50m.—The moon does not seem to the naked eye of so bright a red as before; and again I am reminded by its tint of red-hot copper, or rather copper which has begun to cool. The whole of Grimaldus is now uncovered. Through the telescope I notice a decided gray shade at the lower part of the eclipsed portion, and the various small craters give it a stippled effect, like the old aqua-tint engravings. The upper part is reddish, but two graceful bluish curves, like horns, mark the form of the Hercynian mountains, and the bright region on the other limb of the moon. These are visible also to the naked eye."

At 3h. 5m. the redness had almost disappeared; a very few minutes afterwards, no trace of it remained, and ere long clouds came on. I watched the moon, however, occasionally gaining a glimpse of its disc, till a quarter to four o'clock, when, for the last time on that occasion, I saw it faintly appearing through the clouds, nearly a full moon again; and then I took leave of it, feeling amply repaid for my vigil by the beautiful spectacle which I had seen.

MARY WARD.

Trimleston House, near Dublin.

* Any reader of RECREATIVE SCIENCE, who happens to be dexterous in the use of colour, may add much to the effect of the figures by slightly tinting them from the descriptions given in the text.

THE FIRST BUTTERFLY.

WILL any two naturalists agree as to which is indubitably the first butterfly—the first to startle us by its sudden apparition as a dancing dot in the yet inconstant sunbeams? The Brimstone will flitter over a hedgerow in January, so will the Painted Lady, the Peacock's-eye, and the small Tortoiseshell; but the specimens that first appear are relicts of the last year's brood, hatched late, huddled in snug corners, and then wakened by a momentary burst of unseasonable heat. The choice of priority lies between the Common Cabbage and the Small White; and, if we were to cast lots, we should decide for the latter. And a right good and proper harbinger of summer is it; skipping, darting, zigzagging over the garden, like Psyche herself, restless for the beginning of joys which Jupiter promised should last for ever. H.

A CATALOGUE OF ALL THE COMETS WHOSE ORBITS HAVE HITHERTO BEEN COMPUTED.

(*Continued from page* 249.)

No.	Year.	PP.	π.	☊.	ι.	q.	ε.	μ.	Calculator.	Date of Discovery.	Discoverer.	Duration of Visibility.
		d. h.	° '	° '	° '							
137	1821	Mar. 21, 12	239 29	48 40	73 3	0·0918	...	—	Rosenberger	1821, Jan. 21	Pons	15 weeks.[1]
138	1822 i.	May 5, 14	192 43	177 26	53 37	0·5044	...	—	Nicollet	1822, May 12	Gambart	7 weeks.[2]
(100)	— ii.	May 23, 23	157 11	334 25	13 20	0·3459	0,84446	+	Encke	— June 2	Rümker	3 weeks[3]
139	— iii.	July 16, 12	218 32	97 40	38 12	0·8367	...	—	Heiligenstein	— May 31	Pons	2 weeks.[4]
140	— iv.	Oct. 23, 18	271 40	92 44	52 39	1·1450	0 99630	—	Encke	— July 13	Ditto	17 weeks.[5]
141	1823	Dec. 9, 10	274 34	303 3	76 11	0·2265	...	—	Ditto	1823, Dec. 29	Several observers	13 weeks.[6]
142	1824 i.	July 11, 12	260 16	234 19	54 34	0·5912	...	—	Rümker	1824, July 15	Rümker	4 weeks.[7]
143	— ii.	Sept. 29, 1	4 31	279 15	54 36	1·0501	1·00017	+	Encke	— July 23	Scheithauer	22 weeks.[8]
(107)	1825 i.	May 30, 13	273 55	20 6	56 41	0·8891	...	—	Clausen	1825, May 19	Gambart	8 weeks.[9]
144	— ii.	Aug. 18, 17	10 14	192 56	89 41	0·8834	...	+	Ditto	— Aug. 9	Pons	3 weeks.[10]
(100)	— iii.	Sept. 16, 6	157 14	334 27	13 21	0·3448	0·84488	+	Encke	— July 13	Valz	8 weeks.[11]
145	— iv.	Dec. 10, 16	318 46	215 43	33 32	1·2408	0·99536	—	Hansen	— July 15	Pons	12 months.[12]
(87)	1826 i.	Mar. 18, 9	109 45	251 28	13 33	0·9025	0·74657	+	Santini	1826, Feb. 27	Biela	8 weeks.[13]
146	— ii.	April 21, 23	116 54	197 38	40 2	2·0111	...	+	Clausen	1825, Nov. 6	Pons	22 weeks.
147	— iii.	April 29, 0	35 48	40 29	5 17	0·1881	...	—	Clüver	1826, Mar. 29	Flaugergues	9 days[14]
148	— iv.	Oct. 8, 22	57 48	44 6	25 57	0·8528	...	+	Argelander	— Aug. 7	Pons	15 weeks.[15]
149	— v.	Nov. 18, 9	315 31	235 7	89 22	0·0268	...	—	Clüver	— Oct. 22	Ditto	11 weeks.[16]
150	1827 i.	Feb. 4, 22	33 30	184 27	77 35	0·5065	...	—	Heiligenstein	— Dec. 26	Ditto	5 weeks.
151	— ii.	June 7, 20	297 31	318 10	43 38	0·8081	...	—	Ditto	1827, June 20	Ditto	4 weeks.[17]
152	— iii.	Sept. 11, 16	250 57	149 39	54 4	1·1378	0·99273	—	Clüver	— Aug 2	Ditto	10 weeks.[18]
(100)	1829	Jan. 9, 17	157 17	334 29	13 20	0·3455	0·84462	+	Encke	1828, Oct. 13	Strüve	15 weeks.[19]
153	1830 i.	April 9, 7	212 11	206 21	21 16	0·9214	0·99938	+	Hadenkamp and Mayer	1830, Mar. 16	D'Abadie	22 weeks.[20]
154	— ii.	Dec. 27, 15	310 59	337 53	44 45	0·1258	...	—	Wölfers	1831, Jan. 7	Herepath	9 weeks.[21]
(100)	1832 i.	May 3, 23	157 21	334 32	13 22	0·3434	0·84541	+	Encke	1832, June 1	Mossotti	(?)[22]
155	— ii.	Sept. 25, 12	227 55	72 26	43 18	1·1836	...	—	E. Bouvard	— July 19	Gambart	4 weeks.[23]
(87)	— iii.	Nov. 26, 2	110 0	248 15	13 13	0·8790	0·75146	+	Santini	— Aug. 25	Dumouchel	18 weeks.[24]
156	1833	Sept. 10, 4	222 51	323 0	7 21	0·4584	...	+	Peters	1833, Oct. 1	Dunlop	2 weeks.
157	1834	April 2, 15	276 33	226 48	5 56	0·5150	...	+	Petersen	1834, Mar. 8	Gambart	6 weeks.[25]
158	1835 i.	Mar. 27, 13	207 42	58 19	9 7	2·0413	...	—	W. Bessel	1835, April 20	Boguslawski	5 weeks.
(100)	— ii.	Aug. 26, 8	157 23	334 34	13 21	0·3444	0 84503	+	Encke	— July 22	Kreil	9 weeks.[26]
(4)	— iii.	Nov. 15, 22	304 31	55 9	17 45	0·5865	0·96739	—	Westphalen	— Aug. 6	Dumouchel	41 weeks.[27]
(100)	1838	Dec. 19, 0	157 27	334 36	13 21	0·3440	0·84517	+	Encke	1838, Aug. 14	Boguslawski	16 weeks.[28]
159	1840 i.	Jan. 4, 10	192 11	119 57	53 5	0·6184	1·00020	+	{ Peters & Strüve }	1839, Dec. 3	Galle	10 weeks.[29]
160	— ii.	Mar. 13, 2	80 12	236 50	59 12	1·2204	0·99323	—	Loomis	1840, Jan. 25	Ditto	9 weeks.[30]
(14)	— iii.	April 2, 12	324 10	186 4	79 51	0·7420	...	+	Petersen	— Mar. 6	Ditto	3 weeks.[31]

[1] Discovered by Nicollet on the same day, and by Blainpain, January 25. Visible to the naked eye, with a tail $2\frac{1}{2}^\circ$ long.

[2] Discovered by Pons, May 14, and by Biela, May 17.

[3] The first predicted apparition of *Encke's comet*. Seen only in New South Wales.

[4] Its apparent motion was very rapid.

[5] Discovered by Gambart, July 16. An elliptic orbit; period assigned, 5444 years; visible to the naked eye, with a tail $1\frac{1}{2}^\circ$ long.

[6] Discovered by Pons, December 29, by Kohler, December 30, and by Santini, January 3. This comet had, in addition to the usual tail turned from the sun, another turned *towards* it.

[7] Seen only in the southern hemisphere.

[8] Discovered by Pons, July 24, and afterwards by Gambart and Harding.

[9] It had a tail $1\frac{1}{2}^\circ$ long. Elements resemble those of 1790 (iii.)

[10] Discovered by Harding, August 23. Orbit remarkable for its great inclination.

[11] An apparition of *Encke's comet*. Discovered by Plana, August 10, and by Pons, August 14.

[12] Discovered by Biela, July 19. Very conspicuous early in October, with a bifid tail 15° long. An elliptic orbit. Period assigned, 4386 years.

[13] An apparition of *Biela's comet*, whose periodicity was now discovered. Found by Gambart, March 9.

[14] Elements uncertain.

[15] The path of this comet crosses the ecliptic near the Earth's orbit.

[16] Discovered by Clausen, October 6, and by Gambart, October 28. Visible to the naked eye, with a tail $\frac{1}{2}^\circ$ long.

[17] Discovered also by Gambart.

[18] At one time supposed to be a return of the comet of 1780 (i.) An elliptic orbit; period assigned, 2611 years.

[19] An apparition of *Encke's comet*, afterwards visible to the naked eye.

[20] Discovered in the southern hemisphere. Visible to the naked eye, with a tail 8° long.

[21] Visible to the naked eye, with a tail $2\frac{1}{2}^\circ$ long.

[22] An apparition of *Encke's comet*. Discovered by Henderson, June 2. Only one observation was made in Europe.

[23] Discovered by Harding, July 29.

[24] The first predicted apparition of *Biela's comet*.

[25] Discovered by Dunlop, March 16.

[26] An apparition of *Encke's comet*. Discovered by Boguslawski, July 30.

[27] The second predicted return of *Halley's comet*. It was visible to the naked eye during the whole of October, with a tail from 20° to 30° long.

[28] An apparition of *Encke's comet*. Discovered by Galle, September 16. Perceptible to the naked eye, November 7.

[29] Perceptible to the naked eye, January 8.

[30] An elliptic orbit; period assigned, 2423 years. Plantamour, however, makes it 13,866 years.

[31] Probably a return of the comet of 1097. It had a small tail.

No.	Year.	PP.	ϖ.	Ω.	ι.	q.	e.	μ.	Calculator.	Date of Discovery.	Discoverer.	Duration of Visibility.
		d. h.	° ′	° ′	° ′							
161	1840 iv.	Nov. 13, 15	22 31	248 56	57 57	1·4808	0·96985	+	Götze	1840, Oct. 27	Bremiker	16 weeks.[32]
(100)	1842 i.	April 12, 0	157 29	334 39	13 20	0·3450	0·84479	+	Encke	1842, Feb. 8	Galle	15 weeks[33]
162	— ii.	Dec. 15, 22	327 17	207 49	73 34	0·5044	...	—	Petersen	— Oct. 28	Laugier	4 weeks.[34]
163	1843 i.	Feb. 27, 9	278 39	1 12	35 41	0·0055	0·99989	—	Hubbard	1843, Feb. 28	Many observers	7 weeks.[35]
164	— ii.	May 6, 1	281 29	157 14	52 44	1·6163	1·00017	+	Götze	— May 2	Mauvais	21 weeks.
165	— iii.	Oct. 17, 3	49 34	209 29	11 22	1·6925	0·55596	+	Le Verrier	— Nov. 22	Faye	20 weeks.[36]
(48?)	1844 i.	Sept. 2, 11	342 30	63 49	2 54	1·1864	0·61765	+	Brünnow	1844, Aug. 22	De Vico	19 weeks.[37]
166	— ii.	Oct. 17, 8	180 24	31 39	48 36	0·8553	0·99960	—	Plantamour	— July 7	Mauvais	35 weeks.[38]
167	— iii.	Dec. 13, 16	296 0	118 23	45 36	0·2512	...	+	Hind	— Dec. 19	Wilmot	12 weeks.[39]
168	1845 i.	Jan. 8, 3	91 19	336 44	46 50	0·9051	...	+	Götze	— Dec. 28	D'Arrest	13 weeks.
169	— ii.	April 21, 0	192 33	347 6	56 23	1·2546	...	+	Faye	1845, Feb. 25	De Vico	9 weeks.[40]
(39)	— iii.	June 5, 16	262 2	337 48	48 41	0·4016	0·98987	—	D'Arrest	— June 2	Colla	4 weeks.[41]
(100)	— iv.	Aug. 9, 15	157 44	334 19	13 7	0·3381	0·84743	+	Encke	— July 4	De Vico	10 days.[42]
170	1846 i.	Jan. 22, 2	89 6	111 8	47 26	1·4807	0·99240	+	Jelinek	1846, Jan. 24	Ditto	14 weeks.[43]
(87)	— ii.	Feb. 10, 23	109 2	245 54	12 34	0·8564	0·75700	+	Plantamour	1845, Nov. 26	Ditto	21 weeks.[44]
171	— iii.	Feb. 25, 7	116 28	102 37	30 57	0·6500	0·79446	+	Hind	1846, Feb. 26	Brorsen	8 weeks.[45]
172	— iv.	Mar. 5, 12	90 27	77 33	85 6	0·6637	0·96224	+	Peirce	— Feb. 20	De Vico	10 weeks.[46]
173	— v.	May 27, 21	82 32	161 18	57 35	1·3762	...	—	Argelander	— July 29	Ditto	11 weeks.[47]
174	— vi.	June 1, 5	240 7	260 28	30 24	1·5287	0·72133	+	Peters	— June 26	Peters	4 weeks.[48]
175	— vii.	June 5, 12	162 0	261 51	29 18	0·6334	0·98836	—	Wichmann	— April 30	Brorsen	6 weeks.[49]
176	— viii.	Oct. 29, 17	98 35	4 41	49 41	0·8306	...	+	Hind	— Sept. 23	De Vico	3 weeks.
177	1847 i.	March 30, 6	276 2	21 42	48 39	0·0425	...	+	Pogson	1847, Feb. 6	Hind	11 weeks.[50]
178	— ii.	June 4, 18,	141 34	173 56	79 34	2·1161	...	—	Von Littrow	— May 7	Colla	30 weeks.
179	— iii.	Aug. 9, 8	21 17	76 43	32 38	1·4847	...	—	Schweitzer	— Aug. 31	Schweitzer	13 weeks.
180	— iv.	Aug. 9, 10	246 41	338 17	83 27	1·7671	...	—	Von Littrow	— July 4	Mauvais	41 weeks.[51]
181	— v.	Sept. 9, 13	79 12	309 48	19 8	0·4879	0·97256	+	D'Arrest	— July 20	Brorsen	8 weeks.[52]
182	— vi.	Nov. 14, 9	274 14	190 50	71 53	0·3291	...	—	Ditto	— Oct. 1	Miss Mitchell	13 weeks.[53]
183	1848 i.	Sept. 8, 1	310 34	211 32	84 24	0·3199	...	—	Sonntag	1848, Aug. 7	Petersen	3 weeks.
(100)	— ii.	Nov. 26, 2	157 47	334 22	13 8	0·3370	0·84782	+	Encke	— Aug. 27	Bond	13 weeks.[54]
184	1849 i.	Jan. 19, 8	63 11	215 10	85 4	0·9599	...	+	Pogson	— Oct. 26	Petersen	20 weeks.[55]
185	— ii.	May 26, 11	235 43	202 33	67 9	1·1593	...	+	Goujon	1849, April 15	Goujon	24 weeks.[56]
186	— iii.	June 8, 4	267 3	30 31	66 59	0·8946	0·99783	+	D'Arrest	— April 11	Schweitzer	20 weeks.[57]
187	1850 i.	July 23, 12	273 24	92 53	68 12	1·0815	...	+	Villarceau	1850, May 1	Petersen	17 weeks.[58]
188	— ii.	Oct. 19, 8	89 20	206 1	40 6	0·5647	...	+	Reslhüber	— Aug. 29	G. P. Pond	9 weeks.[59]
(165)	1851 i.	April 3, 11	49 42	209 30	11 21	1·6999	0·55501	+	Le Verrier	— Nov. 28	Challis	14 weeks.[60]
189	— ii.	July 9, 0	324 10	149 19	14 14	1·1847	0·70001	+	D'Arrest	1851, June 27	D'Arrest	14 weeks.[61]
190	— iii.	Aug. 26, 5	310 59	223 41	38 9	0·9843	0·99685	+	Brorsen	— Aug. 1	Brorsen	8 weeks.[62]
191	— iv.	Sept. 30, 19	338 46	44 29	74 0	0·1410	...	+	J. Breen	— Oct. 22	Ditto	5 weeks.[63]
(100)	1852 i.	Mar. 14, 18	157 51	334 23	13 7	0·3374	0·84767	+	Encke	1852, Jan. 9	Hind	8 weeks.[64]
192	— ii.	April 19, 13	280 0	317 8	48 52	0·9050	...	—	Sonntag	— May 15	Chacornac	3 weeks.[65]

[32] An elliptic orbit; period assigned, 344 years, subject to an uncertainty of about nine years. Possibly a return of the comet of 1490.

[33] An apparition of *Encke's comet.*

[34] Small and faint.

[35] The finest comet of the present century. At one time it had a tail 60° long. The orbit is remarkable for its small perihelion distance. The period assigned is 376 years. This may be a return of the comet of 1668, but many others have also been supposed to be identical with it. (See Cooper's "*Cometic Orbits,*" pp. 162—9.)

[36] Usually known as *Faye's comet.* It had a very small tail. Period, 7·44 years.

[37] Visible to the naked eye. An elliptic orbit; period assigned, 5·469 years. It has not been observed since. Possibly identical with the comet of 1678.

[38] Discovered by D'Arrest, July 9. Visible to the naked eye, November 10. Period, 102,050 years. Subject to an uncertainty of 3090 years.

[39] First seen in the southern hemisphere. It had a tail 10° long.

[40] Discovered by Faye, March 6.

[41] Discovered by Richter, June 6. A fine comet. Visible to the naked eye, with a tail 2½° long. A return of the comet of 1596; period, 250 years.

[42] An apparition of *Encke's comet.* Discovered by Coffin the same evening.

[43] An elliptic orbit; period assigned, 2721 years.

[44] An apparition of *Biela's comet.* Discovered by Galle, November 28. It was at this return that the comet separated into two parts.

[45] An elliptic orbit; period assigned, 5·58 years.

[46] Discovered by G. P. Bond, February 26.

[47] Discovered by Hind two hours later.

[48] Discovered by De Vico, July 2. An elliptic orbit; period assigned, 12·8 years. Subject to an uncertainty of one year.

[49] Discovered by Wichmann, May 1. Visible to the naked eye, May 14. An elliptic orbit; period assigned, 400 years.

[50] Visible in the daytime. It had a tail 1¼° long. The true elements are probably elliptical.

[51] A parabolic orbit best satisfies the observations.

[52] Period assigned, 75 years.

[53] Discovered by De Vico, October 3, by Dawes, October 7, and by Madame Rümker, October 11.

[54] An apparition of *Encke's comet.* Discovered by Hind, September 13. Perceptible to the naked eye, October 6. On November 3 it had a tail more than 1° long.

[55] A parabolic orbit satisfies the observation, but a period of 382,801 years has been assigned ! ! !

[56] It had a small tail.

[57] Discovered a few hours later by Bond, and by Graham, April 14. Period, 8375 years.

[58] Visible to the naked eye, with a tail. Carrington has assigned a period of about 29,000 years.

[59] Discovered by Brorsen, September 5, by Mauvais and Robertson, September 9, and by Clausen, September 14.

[60] The first predicted apparition of *Faye's comet.*

[61] Period, 6·441 years.

[62] Discovered by Schweitzer, August 21. Period assigned, 5544 years.

[63] It had a tail more than 1° long, and also a shorter one turned towards the sun.

[64] An apparition of *Encke's comet.*

[65] Discovered by Petersen, May 17, and by G. P. Bond, May 19. It was very small and faint. Elements resemble those of the comet of 1819 (ii.)

(To be continued.)

GEORGE F. CHAMBERS.

METEOROLOGY OF MARCH.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.
1842	57·0	31·0	—
1843	62·0	23·5	0·6
1844	63·0	21·5	2·4
1845	58·0	13·0	2·0
1846	55·5	26·0	1·2
1847	61·5	23·0	1·1
1848	69·8	26·3	3·9
1849	65·0	24·5	0·5
1850	61·2	17·5	0·3
1851	57·1	27·5	2·9
1852	71·5	18·0	0·6
1853	57·0	18·8	0·7
1854	64·3	23·4	0·5
1855	52·9	20·5	1·1
1856	59·2	22·7	1·0
1857	65·5	25·0	1·7
1858	69·5	16·5	0·8
1859	64·0	25·2	1·7

The greatest heat in shade reached 71·5° in 1852, and only 52·9° in 1855, giving a range of 18·6° in greatest heat for March during the past eighteen years.

The greatest cold was as low as 13° in 1845 (descending 1° below zero on the grass), and never below 31·0° in 1842, giving a range of 18·0° for March during the past eighteen years. The coldest years were 1845, 1850, 1852, 1853, and 1858; and the warmest, 1842, 1846, 1848, and 1851.

Only 0·3 inch of rain fell in March, 1850, and as much as 3·9 inches in 1848, giving a range of 3·6 inches, or above 3½ inches for March during the past seventeen years. In eight years the fall did not exceed an inch, and in four years it was two inches and upwards. The mean fall of rain for March is 1·4 inches.

March is a changeable month, the range of temperature being under 30° in 1842, 1846, and 1851, and being 53° in 1858, and 53·5° in 1852. It is subject to gales of wind. E. J. LOWE.

ASTRONOMICAL OBSERVATIONS FOR MARCH, 1860.

THE sun is in Pisces, and south of the equator, until the 20th, at 9h. 5m. in the morning, when he passes into Aries, and is north of the equator. He rises in London on the 1st at 6h. 47m., on the 10th at 6h. 27m., on the 20th at 6h. 4m., and on the 30th at 5h. 41m. He sets in London on the 1st at 5h. 39m., on the 10th at 5h. 55m., on the 20th at 6h. 12m., and on the 30th at 6h. 28m.

The sun reaches the meridian in London on the 1st at 12h. 12m. 30s.; on the 16th at 12h. 8m. 41s.; and on the 31st at 12h. 4m. 8s.

The equation of time on the 1st being 12m. 30s.; on the 16th, 8m. 41s.; and on the 31st, 4m. 8s.; the clock being these amounts before the sun.

Length of day on the 3rd, 11h. 1m., and on the 19th, 12h. 3m.

Day breaks on the 9th at 4h. 36m., and on the 27th at 3h. 49m.

Twilight ends on the 10th at 7h. 48m., and on the 22nd at 8h. 11m.

Duration of twilight after sunset on the 1st, 1h. 51m.; on the 16th, 1h. 54m.; and on the 31st, 2h. 0m.

The moon is full on the 7th at 12h. 44m. p.m.

New moon on the 22nd at 1h. 56m. p.m.

The moon is nearest to the earth on the 7th, and most remote from us on the 20th.

Mercury is an evening star, and is favourable for observation in the middle of the month. He is nearest to the sun on the 10th, and reaches his greatest eastern elongation on the 16th. He is in Pisces. Mercury rises on the 12th at 6h. 42m., and on the 17th at 6h. 26m.; souths on the 12th and 17th at 1h. 12m. p.m.; and sets on the 12th at 7h. 43m. p.m., on the 17th at 7h. 57m., and on the 22nd at 7h. 55m. p.m.

Venus is now becoming a fine object, and will rapidly increase in apparent size for the next three months. She is an evening star, in Pisces in the beginning of the month, and in Aries and Taurus towards the end. Venus rises on the 2nd at 7h. 46m. a.m.; on the 17th at 7h. 15m., and on the 27th at 6h. 57m.; and sets on the 2nd at 9h. 8m. p.m., on the 17th at 9h. 55m., and on the 27th at 10h. 25m. p.m.

Mars is unfavourably situated for observation, but is increasing in size and brightness; he is in Ophiuchus at the beginning, and in Sagittarius at the end of the month. He is a morning star, rising on the 2nd at 2h. 30m. a.m., and on the 27th at 1h. 58m. a.m. He is visible in S.E. at 3 a.m.

Jupiter, though not so bright, is still a fine object in the constellation Gemini. He rises on the 2nd at 12h. 10m. p.m., and on the 27th at 10h. 34m. a.m.; souths on the 2nd at 8h. 23m. p.m., and on the 27th at 6h. 46½m. p.m., setting on the 2nd at 4h. 40m. a.m., and on the 27th at 3h. 4m. a.m.

Saturn is favourably situated, he is an evening star, and is still in the constellation of Leo. He rises on the 1st at 6h. 26m. p.m., on the 21st at 5h. 5m., and on the 31st at 4h. 25m. p.m.; and souths on the 1st at 10h. 56m. p.m., and on the 31st at 8h. 52m.

Uranus is still in Taurus, and is visible during the evening, rising on the 2nd at 9h. 26m. a.m., and on the 27th at 7h. 50m. a.m.; southing on the 2nd at 5h. 25m. p.m., and on the 27th at 3h. 50m. p.m.; and setting on the 2nd at 1h. 29m. a.m., and on the 27th at 11h. 50m. p.m.

The new Intra-Mercurial Planet: according to M. Le Verrier, a transit across the sun's disc will take place some time between March 25th and April 10th.

Eclipses of Jupiter's satellites at Greenwich:—On the 1st, at 1h. 5m. 47s. a.m., 1st moon reappears. On the 2nd, at 7h. 34m. 33s. p.m., 1st moon reappears. On the 5th, at 2h. 41m. 34s. a.m., 2nd moon reappears. On the 8th, at 3h. 1m. 1s. a.m., 1st moon reappears. On the 8th, at 7h. 48m. 48s. p.m., 4th moon disappears. On the 8th, at 11h. 46m. 15s. p.m.,

4th moon reappears. On the 9th, at 9h. 20m. 49s. p.m., 1st moon reappears. On the 16th, at 11h. 25m. 9s. p.m., 1st moon reappears. On the 22nd, at 9h. 11m. 52s. p.m., 2nd moon reappears. On the 24th, at 1h. 20m. 33s. a.m., 1st moon reappears. On the 25th, at 7h. 49m. 26s. p.m., 1st moon reappears. On the 25th, at 8h. 12m. 54s. p.m., 3rd moon reappears. On the 29th, at 11h. 47m. 44s. p.m., 2nd moon reappears.

At 10 p.m., meantime, on the 8th, the 1st moon is on the body of Jupiter, and again on the 31st. On the 20th, the second moon is on the body, and on the 21st, the 3rd moon is on the body, of Jupiter.

Occultations of Stars by the Moon at Greenwich :—On the 4th, δ Cancri (4th magnitude star) disappears at 7h. 14m. p.m., and reappears at 8h. 15m. p.m. On the 5th, 18 Leonis (5th magnitude star) disappears at 9h. 12m. p.m., and reappears at 10h. 18m. p.m. On the 5th, R Leonis (variable star) disappears at 10h. 7m. p.m., and reappears at 11h. 13m. p.m.

VENUS.

Illuminated Portion of the Discs of Venus and Mars on March 15th :—Venus = 0·745 ; Mars = 0·884.

E. J. LOWE.

THINGS OF THE SEASON—MARCH.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

—o—

BIRDS ARRIVING.—Bunting, Reed Sparrow, Red-legged Sea-mew, Stone Curlew, Least Willow Wren., Wheatear.

BIRDS DEPARTING.—Teal, Widgeon, Snipe, Woodcock, Solan Goose, Fieldfare, Merlin, Red-headed Pocher, Turnstone, Redwing, Thrush.

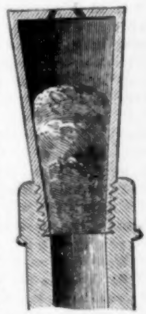
INSECTS.—Byrrhus pilula, Opilus mollis, Leistus fulvibarbis, Pœcilus cupreus, Stomis pumicatus, Whirlwig Beetle, Necrophorus vespillo and mortuorum, Lesser Stag Beetle, 22-spotted Coccinella, Orange Underwing, March Moth, Chrysomela litura, Pedinus femoralis.

WILD PLANTS IN FLOWER.—Spring Crocus, Sweet Violet, Daffodil, Star of Bethlehem, Two-leaved Squill, Mezereon, Cotton Grass, Blackthorn, Strawberry potentilla, Pasque Flower, Lesser Celandine, Marsh Marigold, Colt's-foot, Ground Ivy, Wood Spurge, Alder, Small-leaved Elm, Butcher's-broom, Poplars.

Mr. Noteworthy's Corner.

FOOD FOR TAME FISHES.—One of Mr. Noteworthy's friends feeds his fishes with boiled rice, and they eat it greedily, and thrive upon it. The rice is boiled in water till quite soft, then drained nearly dry, and of course given when cold. Carp of all kinds, minnows, roach, and other fishes in the aquarium, like it exceedingly.

CHEAP GAS REGULATOR.—Gas requires a certain proportion of atmospheric air to be mixed with it, in order to obtain proper combustion in connection with the evolution of as large an amount of light as possible. The reason urged for putting on great pressure at the works is, that the gas, being much lighter than common air, shows decided disinclination to go down-hill itself, beyond the level of its birth-place, and make its appearance in depressed situations; force is therefore found requisite to make it "move on," and as this cannot be so nicely adjusted as to suit all circumstances, fizzing is the result. To remedy this various appliances have been tried, the general object being to retard the flow of gas near the point of combustion, by adding chambers filled with different materials after the manner of a filter. To remedy the fizzing, it is only necessary to unscrew the nib, and partially fill it with a piece of unravelled string, pressed in more tightly according to the amount of relief required; screw the nib on again, and the operation and regulator will be completed. For this Mr. Noteworthy is indebted to Mr. Thomas Goodchild, of Reading.



Section of Gas-nib, as filled.

METEOROLOGY OF 1859.—In looking over his weather journal, Mr. Noteworthy finds that the chief meteorological phenomena of 1859 may be classed under three heads. First, as to temperature, the spring and autumn were severely cold, sharp frosts and snow came at the end of March, continued intermittedly till the end of May, and again in October frost again occurred, and lasted till nearly the end of the year. Between these two rigorous seasons occurred an intensely hot summer, which in the month of July attained to an oppressive degree of heat. Secondly, as to the duration of the summer. There was no frost *in the air* from April 23 to October 22, a period of twenty-four weeks. There was no frost on grass at night from May 9 to October 21, a period of twenty-two weeks. Thus the summer was of the same length as in 1858. In 1857, the summer lasted only twenty weeks, and in 1856 only fourteen. In atmospheric phenomena the year was remarkable for numerous and severe storms. The register at Lloyd's reveals many a sad story of marine disaster besides that of the "Royal Charter." There were 500 bodies strewed upon our coasts in one week. On the 2nd of July occurred a tremendous storm of hail near London, which in one nursery alone destroyed more than an acre of glass. That storm was followed by three weeks of intensely hot weather. The storm was foretold by the barometer, as was also the circular hurricane later in the year, by which the great ship was charred into fragments within a gunshot of her home.

Other People's Pets.—There is a great gap in our moral laws, and I do not know but what the criminal law ought to take notice of it, and make the meddling with other people's pets a penal act. I can't complain of a man who poisons my cat, because if she goes on his premises she must take her risk of what may befal her; and I know that if my neighbour hangs his canary on his own grape-vine, my cat is not sufficiently neighbourly to respect it. But why does my friend poke his stick into my squirrel-cage to make my little "Frisky" show his agility, that he—the friend of my bosom—may enjoy a silly laugh? People who would complain loudly if one were to teach their dogs to snap and their cats to steal, will go to your parrot, and tempt her with their meddling fingers, that she may learn to hate strangers; they will seize your pet Billy-goat by the horns to try his strength, and spoil his temper, and as for your gold-fishes, they will throw cakes and scraps of bread to them, to poison the water and frighten the pretty things to death. When I visit a friend I make it a rule never to put my fingers on anything, either in his house or garden, and when I see a friend taking the liberty of walking off the path to get at something, I feel inclined—but no matter, I bear the crushing of my seedlings, the snapping of my raspberry-stems, and the disjointing of my cucumbers, with the patience of Job. Fingers that itch to meddle with other people's pets deserve to be chopped off, and he who cannot respect the fruits of another's labour, and the objects of another's fondness, ought, so Mr. Noteworthy thinks, to be shut out of society altogether, or taken in the act, and ——!

Suggestion for a Binoscopic Toy.—Standing one summer's day near a garden-hedge, I looked through it at a man loading a cart with hay in the adjoining field—the man and cart being at some little distance from the place where I had stationed myself; when presently I was surprised at perceiving a second person, as I thought, assisting him. So complete was the delusion, that I, for some minutes, paused to consider who this second person could possibly be. I looked again, and still there were two men, one following the other, and both busily employed in lifting the hay with forks. Presently, however, it occurred to me that their movements and dress were exactly similar, and on closer inspection I found that these two persons were in reality two images of the same haymaker, formed with the utmost precision by some arrangement of the leaves and sprays, between whose lattice-work the picture found its way to my eyes. I tried the experiment again and again at different times, and with different objects, and I found that by getting certain leaves or sprays between my eyes, and the object under observation, it could be doubled very distinctly and separately, each image being equally clear. How the intervening leaves and sprays were arranged I could not quite discover, but I supposed that they in some way intercepted the rays of light, so as to cause each eye to see the object in a slightly different situation. The stereoscope reduces two pictures to one, and it occurred to me that those better acquainted with optics than myself might be able to invent some amusing toy which could thus be made to multiply one picture into two.—M. G. C.

Lightning-rods.—The conductor, or lightning-rod, which has always been regarded as one of the proudest trophies of science, was known and employed by people of no more refined cultivation than the wild peasantry of Lombardy. The Abbé Berthollet, in his work on electricity, describes a practice used on one of the bastions of the Castle of Duino, on the shores of the Adriatic, which has existed from time immemorial, and which is literally neither more nor less than the process which enabled Franklin to bring lightning down from the clouds. An iron staff, it seems, was erected on the bastion of the castle during the summer, and it was a part of the duty of the sentinel, whenever a storm threatened, to raise an iron-pointed halbert toward this staff. If, on the approach of the halbert sparks were emitted (which, to the scientific mind, would show that the staff was charged with electricity from a thunder-cloud), the sentinel was made sure that a storm impended, and he tolled a bell which sent forth the tidings to the surrounding country. Nothing can be more delightfully amiable than the paternal care of its subjects which this provision of the local government exemplified. The admonishing sound of the bell was obeyed like a preternatural signal from the depth of the firmament. Shepherds were seen hurrying over the valleys, urging flocks from exposed fields to places of shelter; the fishing-boats, with which the coast of the Adriatic was generally studded, forthwith began to crowd sail, and make for the nearest port; whilst many a supplication was put from many a gentle and devout heart on shore, before some hallowed shrine, for the safety of the little fleet.

Do Dogs Understand Human Speech?—The replies forwarded to the query of Mr. Westcott would suffice to fill a volume, and the purport of them all is—Yes. "Recreative Science" is not a mere book of anecdotes, and therefore we cannot make room for the many instances of canine sagacity with which correspondents have favoured us. Let one anecdote suffice, and it is one that Mr. Noteworthy pronounces to be true. A game-keeper went afield without his belt. When some miles from home he said to his dog, "I forgot my belt; go back and get No. 6." The dog went home, went to the shed where the belts were hung, and barked for help. His mistress handed him belt No. 1—"No." Then No. 2—"No." Then No. 3, and so on to No. 6, which the dog seized with a whine of delight and a fearful wagging of his tail, and started away with it. The dog understood his master's speech; but mark, the speech had to do with affairs with which the dog was familiar, and clever dogs at once attach to such words their proper meaning. A discourse on ethics would not be understood, nor perhaps would any mere words without accompanying gestures expressive of their meaning.

Luganure Lead Mine, County Wicklow, Ireland.

LEAD IN TWO PARTS.

PART I.—THE MOUTH OF THE MINE.

If we want a substance which shall be sufficiently fusible to admit of its being readily cast into any required form, which shall be flexible enough to make into long tubes, tenacious enough to form large sheets, and possess at the same time the important property of resisting aqueous and atmospheric action, we shall find, on looking over the twelve or fourteen metals which have been provided for us, that there are but two which combine in themselves all these advantages.

These two metals are tin and lead. Now, tin is expensive, for it does not occur in large quantity in nature, so that we are obliged to fall back upon its more abundant relation. There are some purposes, moreover, for which tin would be unfitted, and for which lead only can be employed. In some of these cases, the peculiar property which is taken advantage of is its easy fusibility, rendering it possible to recast any objects which may be imperfectly formed. If we had not lead, we might still, like the Chinese, be printing from wooden type. In others it is its peculiar softness which constitutes its superiority for some given object over any other metal. No other substance, for example, is so perfectly suited for forming projectiles for rifled fire-arms, as even tin bullets would soon, by tearing the interior of the bore, impair the accuracy of the weapon. It is this very softness, too, which has recently been taken advantage of in the construction of shells for the Armstrong gun, the projectiles being coated with lead, which, by the explosion of

the charge, is forced into the grooves of the bore. In other cases, again, the valuable property for which lead is chosen is the readiness with which it enters into union with other metals to form alloys no less useful than lead itself. Illustrations of these are found in ordinary plumber's solder, pewter, and shot-metal. To the manufacturing chemist lead is invaluable, as it affords him a means of cheaply constructing apparatus, which is unacted on by the most powerful agents with which he has to do.

It is fortunate, then, when all these important applications of lead are taken into consideration, that it is abundant. Without entering into statistical details, it will be sufficient to say that Great Britain and Ireland produce about 73,000 tons annually, and that Spain and America also supply it in large quantity. Not only is lead plentiful, but it is easily extracted from its ores; for although occasionally found in the metallic state, such an occurrence is very unusual, and the quantity thus obtained is of no commercial importance whatever. The ores of lead are very numerous, consisting of the sulphide, carbonate, oxide, chloride, phosphate, sulphate, arseniate, and chromate; but as the quantity in which the last seven occur is exceedingly small, their interest is chiefly confined to the mineralogist, and the sulphide is the principal source of the lead of commerce. The two counties of Durham and Northumberland produce nearly one-fourth of the lead ore of the United Kingdom, the rest coming principally from South Wales. Although Ireland has no very rich mines of this metal, still those which are in the hands of the Mining Company are worked in a very creditable manner, and all the most recent refinements of science are brought to bear upon the profitable management of the ore, and the after treatment of the lead.

Not many months since, during a walking tour in Wicklow, I made, for the first time, the acquaintance of Glendalough, a region which has ever been sacred to the antiquarian, and beloved by the more refined among Dublin pleasure-seekers. It was in the twilight of an August evening that the cross and round tower of one of the most conspicuous of the Seven Churches, with its background of rippled water, seemed suddenly to emerge from the embrace of the surrounding cliffs, and the lights in the white cottages twinkled with an air of comfort and invitation which to me, a tired pedestrian, was especially welcome. Half an hour before I had passed through a village which presented a scene of activity, and an appearance of comfort which was not only in marked contrast to all that I had seen in Wicklow, but is much too unusual altogether in Ireland. On inquiry, I found that this was Laragh, a hamlet which has sprung up entirely out of the exertions of the Mining Company, who have established schools and built dwellings for those in their employment. I learned, also, that at the "Churches" a very extensive lead-mine was in full operation, and I hailed the fact with delight as an addition to my share of sight-seeing.

Next morning I started to see the mine, and again the marked difference to any other part of the county struck me. Here I met the miners by dozens, going to their work; here their wives and daughters carrying their breakfasts, and the candles with which they light the mine; and every now and then I passed neat cottages, with patches of flower-garden in front, a marked improvement, as the reader who has any experience of Irish cottages will readily admit, upon the customary and time-honoured pool of dirty water. I notice these circumstances, which might appear out of place here, as examples of the way in which scientific industry affects the prosperity of a country, and because I know of no more delightful spectacle than English habits of comfort engrafted upon Irish warmth of heart, and their effects made manifest upon Irish soil.

The first objects which attract attention at the mouth of our lead-mine, are a very large water-wheel, turned by the mountain stream, which rushes down the ravine in front, and several immense heaps of what appears to be fine white gravel, but which is really the *debris* of the mine. Further on, we come upon several men busily engaged with hammers upon a huge heap of glistening stone, which it is not difficult to tell is the lead ore. But to see everything, and not bring away merely a confused idea of the whole, we must begin at the beginning.

A visit to the mine itself, however, would hardly repay us for the trouble and inconvenience of getting there; we should only see the miners with their pickaxes, cutting away the lead, containing quartz, from the solid rock, and selecting such pieces to be conveyed above ground as are sufficiently rich in metal to be worth working. For, by a very judicious arrangement, the miner is not remunerated for the time he works, nor even for a certain quantity of ore brought to the surface, but the Company purchase from him the dressed ore, in a condition fit for smelting, at a price which of course varies with the market value of lead, debiting him, meanwhile, with all implements used, and with the cost of dressing. Nothing can be more just or more to the advantage of all parties than this. The Company are not paying for unremunerative labour, and the miner shares equally with the Company in the profits of the speculation. Of course this principle is only carried out when the mine is in full operation, for the expense of preliminary operations and the chances of the mine proving profitable all fall upon the Company.

First of-all, then, the galena, which in this, as in most other cases, occurs in a quartz formation, after having been dug out, is placed in trucks, two of which are attached to either end of a long chain, which passes over a pulley. The trucks run upon two parallel lines of railway down the side of the hill, in such a manner that the two descending trucks laden with ore shall draw up to the entrance, or "level," of the mine, the two others which had been relieved of their load. Down they come, with a speed which every moment increases until the level ground is reached, and even then they have sufficient inertia to propel them right up to the shed in which is situated the crushing-machine. A terrible engine is this, unrelenting, remorseless, crushing the tough galena into fragments, with as little difficulty as a grocer's mill grinds coffee-beans. And now the ore, separated as completely as is possible from the quartz which has so long borne it company, has arrived at an important crisis in its history, and we will see how it fares. The building which contains the crushing-machine is two-storied, and it is into the upper story that the ore-laden trucks are made to pass. We now know the secret of the water-wheel, for entering down stairs we see two inflexible iron cylinders moving, by a cunning arrangement of cogged wheels, in opposite directions.

These cylinders, which are "case hardened," or superficially converted into steel, are so close together, that an ordinary pencil passed between them would emerge beneath as a flat band, and this contiguity is kept up by means of a heavy weight, or "bob," attached to the extremity of a lever, which bears upon one of them. The ore supplied from above, through a hopper, comes down in a steady, gradual stream, falling fairly between the cylinders, and is soon reduced to fragments. But with such hard work to do, it is not to be expected that it should be performed very rapidly. The crushed ore falls into a tubular sieve, which, being gently inclined, allows those fragments which do not pass through its meshes to slide into a bucket placed to receive them. The finer portions—almost dust now—pass through, and are swept by an attendant boy into a wooden gutter or channel. When the bucket is full of the im-

perfectly-crushed ore, a signal is given; it is hauled up to undergo a repetition of the process; and this is continued until the whole is reduced to an uniform condition of fineness.

Even now, notwithstanding the sorting process, a very considerable amount of quartz remains intermixed with the crushed ore, and as this would very much interfere with the subsequent smelting, it becomes necessary to remove it. In order to understand the principle upon which the operation next to be described is based, the reader must remember that galena is very much heavier than quartz; and that, supposing a mixture of two substances, one heavy and the other light—as sand and shot, for example—to be thrown into a running brook, the sand would be carried to some distance by the water, while the shot would remain almost at the place where it was thrown in.

It is by taking advantage of this difference in specific gravity, that the separation of the galena from the "gangue," as it is called, is effected. After passing from the sieve, the crushed ore meets in the gutter or channel with a stream of water, which, having already turned the water-wheel, is further made to wash the ore, and still come along pretty rapidly and with some force. Very soon the effect of its action is made manifest. At intervals along the water-course are lateral openings into shallow tanks, and here are stationed men, armed with instruments like a rake minus the teeth, who draw into the reservoirs the galena which accumulates in the channel. Towards the upper extremity of this simple washing apparatus, are found lumps of galena; but as we go lower down, we find that these diminish in size, until, having degenerated into a mere plumbeous sand, the lead ceases altogether, and in its stead we come upon nothing but the rejected quartz, the particles of which, in the same manner, grow small by degrees, and finally dwindle into dust. At the upper part, where the galena lies in small lumps, we find quartz in rather larger fragments, which have resisted the impulse of the stream, and remain intermixed with the ore. This portion is reserved for treatment in a series of oblong boxes, which have a jerking motion communicated to them. These boxes are filled with the mixed ore and quartz, and in the same way as shaking a basket of chips and halfpence would determine the subsidence of the latter to the bottom, does the galena separate itself from the less heavy quartz, which is removed from time to time to make room for a new supply. When removed from the washing-tubs, the galena is placed in heaps, each of which is the share of a miner. With the correct weighing and transference of the ore to long coffin-shaped boxes, in which, securely padlocked, it is conveyed to the smelting-works, the mechanical part of its treatment ends, and it bids farewell to the mine.

Dublin. HARRY NAPIER DRAPER.

STAR SCINTILLATIONS.

WE are informed by Humboldt, that in the tropics the stars shine with a steady lustre, not twinkling or scintillating as they appear in our zone. The cause of this appears to me very simple, and I will proceed to explain it. Between ourselves and the stars there are many atmospherical strata of various densities, which diversity in density of strata may perhaps extend to the ether beyond the limits of our atmosphere, if such exists. It appears that this diversity of density causes the apparent twinkling of the stars, because we find the same phenomena in connection with terrestrial objects. If we look at a gas jet at a distance, it will appear surrounded with scintillations, which are not seen if we are close to it. These are more apparent when the weather is foggy, because the diversity in the densities of the strata is then greatest. J. A. DAVIES.

HISTORY AND USES OF THE HEMP.

The common European hemp, *Cannabis sativa*, is the same plant as the one called *C. Indica*. It has been from the remotest period cultivated and highly esteemed, especially in Eastern countries, for the narcotic properties which it possesses, and, in the more temperate regions, for the valuable fibre which is easily separated from its stems. Herodotus (l. 4, c. 75) informs us that the Scythians had a custom of burning the seeds of this plant in religious ceremonies, and that those who inhaled it became intoxicated with its fumes. Galen also mentions the intoxicating properties of hemp, and it is supposed to be this plant which Homer makes Helen administer to Telemachus to make him forget his sorrows. The hemp belongs to the same natural order of plants as the nettle, which we have before spoken of (p. 77). It is believed to be a native of India, and to have been brought to Europe from Persia, and, like many other plants, has the wonderful power of adapting itself to almost any soil and climate. From this circumstance and its great utility, it is now cultivated in almost all parts of the world. Amongst the Eastern nations, it is chiefly cultivated for the narcotic properties which it contains; but in the Northern countries it does not appear to possess the same quantity of the narcotic principle, and is there cultivated more especially for the valuable fibre which is found in the stems.

Throughout the whole of Italy, and in most of the southern provinces of France, and in almost every part of Germany, the cultivator of the soil allots a certain portion of his land to the growth of the hemp; and the industrious women, both young and old, especially in the rural districts of Italy, may be seen, while tending their flocks and herds, busily engaged spinning it in the ancient manner, with the distaff (Fig. 1), which is generally made of a portion of the stem of the bamboo; they afterwards wind the thread upon bobbins, and weave it into various fabrics for domestic use; but it is chiefly in the northern parts of Russia, even as far north as Archangel, that the hemp is grown as an article for exportation, and it is from that country that our manufactories obtain the greater portion of their supplies.

Fig. 1.

The plant grows from six to twelve feet high, and is more or less branched, terminating in a bunch of greenish flowers. The leaves are large, divided into five to eight narrow lanceolate serrated segments in a palmated manner; and when the plant is grown separated from others, it has a pretty, graceful appearance (Fig. 2.) When the plants have attained their full growth, they are pulled up, and the roots chopped off, and then spread out to dry in the sun; when they are sufficiently dry they are beaten so as to separate from the stem the leaves and smaller branches; the stems are then immersed in pools or streams of water, until they undergo a species of putrefaction, and when large quantities are going through this process, the stench arising from them is extremely offensive. By being thus steeped in water, the glutinous matter of the plant is destroyed, and the fibre is in a great measure liberated.

They are then taken out of the water, and spread out to dry and bleach in the sun. The

FIG. 2.

whole, except the woody fibre, is now become very brittle; it is then beaten and chopped between stout pieces of wood arranged for the purpose, and the fibre separated from the rest of the vegetable matter. It is then combed, and tied up into convenient-sized bundles for home use or sale.

The roots of the hemp are very liable to be attacked by one of the species of that curious tribe of parasitical plants the *Orobanche*, and, from its stem being branched, it is called the *O. ramosa* (Fig. 3). It grows from six to twelve inches high, is of a pale-yellowish brown colour, and bears a few scattered brown membranous scales in the place of leaves; its flowers are numerous, of a pale purplish colour. An ordinary-sized plant bears about sixty-six capsules, and in each there are about 1100 small, but very beautiful-looking seeds; so that one plant alone furnishes no less a number than 72,600 seeds! each of which is capable of producing a plant, and as the seeds of the Orobanche are known to remain a considerable time in the ground without losing their vitality, the chances of their ultimate development on the roots of the hemp are increased.

I have observed, in a field where the hemp has grown, the roots very much infested with this plant, but still the plants of the hemp on which it grew were apparently uninjured by it. The field was sown with wheat, turnips, and other crops, on, I believe, the five succeeding years; but not a plant of the Orobanche was to be found, but hemp was again sown, and then there sprang up an abundance of this pretty parasitical plant.

FIG. 3.—Orobanche ramosa.

In the sap of the hemp there exists a peculiar resinous substance, which possesses narcotic properties. A hemp-field, especially in a southern climate, when the hot rays of the sun are acting upon it, has a peculiar odour, which often produces, in persons who remain any length of time in it, headache and giddiness. This probably arises from the volatile narcotic principle being evaporated and suspended in the surrounding atmosphere, and is consequently inhaled, and produces its specific effect. The quantity of this narcotic principle, which is of a resinous character, is much greater in the plant when grown in hot countries than it is in colder regions; but the fibre is not so good, and is,

indeed, considered worthless. The resin, however, is so abundant as often to exude from the plant, and is gathered for use. The whole plant abounds in it, and it is used in various ways, and extracts are made from it, and names are given to the different preparations. The resin, which exudes naturally from the plant, is the most esteemed, and is called *momœa*, or *churrus*. When the whole plant is collected and dried, it is sold in Calcutta market under the name of *gunjah*. If the larger leaves and capsules are dried together, it is known as *bang*, *subjea*, or *sidhæ*. When the tender tops and leaves of the plant are collected, and dried, it is called *haschisch*, or by the Egyptians *hhashee'sh*, and this they commonly mix with tobacco, and smoke it. The dried flowers the Moors call *kief*, which they smoke in the same way as tobacco, but a small pipeful of it is sufficient to produce intoxication. An extract made by infusing the whole plant in an alcoholic solution, and then evaporated, is said to be very active; but the extract called by the Arabs *dawamese* is the form most commonly used. It is made by boiling the leaves and flowers of the hemp in water, to which a certain portion of fresh butter is added, and then evaporated to the thickness of a syrup; in this state it has a very disagreeable taste, and to disguise it there is generally added some aromatics, such as camphor, cloves, nutmeg, and thus it is formed into a kind of electuary. This composition is said to form the chief ingredient of the *haschisch* of many Eastern nations. A preparation similar to this is called by the Moors *el mogea*, and is sold at a very high price.

"The practice of chewing the leaves of this plant, to induce intoxication, prevailed or existed in India in very early ages: hence it was introduced into Persia, and about six centuries ago (before the middle of the thirteenth century of our era) this pernicious and degrading custom was adopted in Egypt, but chiefly by persons of the lower order, though several men eminent in literature and religion, and vast numbers of fakeers (or poor devotees), yielded to its fascinations, and contended that it was lawful to the Moos'lem. The habit is now very common among the lower orders in the metropolis, and other towns of Egypt." The same author says: "The preparation of hemp used for smoking generally produces boisterous mirth. Few inhalations of its smoke, but the last very copious, are usually taken from the gozeh. After the emission of the last draught from the mouth and nostrils, commonly a fit of coughing, and often a spitting of blood ensues, in consequence of the lungs having been filled with the smoke. Hhashæ'sh is to be obtained not only at some of the coffee-shops; there are shops of a smaller and more private description, solely appropriated to the sale of this and other intoxicating preparations; they are called mahh'shesh'ehs. It is sometimes amusing to observe the ridiculous conduct, and to listen to the conversation of the persons who frequent these shops. They are all of the lower order. The term hhash'sha'sh, which signifies a smoker, or an eater of hemp, is an appellation of obloquy. Noisy and riotous people are often called hhash'sha'shee'n, which is the plural of that appellation, and the origin of our word "assassin"—a name first applied to Arab warriors in Syria, in the time of the Crusades, who made use of intoxicating and soporific drugs, in order to render their enemies insensible."*

The effect which the administration of the preparations of hemp produces varies greatly in different individuals. Its general effect upon Orientals is that of an agreeable and cheerful character, some individuals, however, become quarrelsome and violent. Its action upon Europeans, at least in Europe, is considerably less than upon the nations of hotter climates. The very general use of some form or other of the hemp in almost all hot climates would lead us to imply that it has not any injurious

* Lane's "Modern Egyptians," vol. ii., p. 32.

effects upon the system, but rather that it was agreeable and soothing; the abuse of it, however, is exceedingly debasing, and renders those habituated to its use unfit for the ordinary affairs of life. I have, however, occasionally met with individuals who, labouring under some painful chronic disease, were relieved by its daily administration.

Hemp is used, in some form or other, for its narcotic properties in all parts of India, in Persia, the East of Europe, and in all Mohammedan countries. In northern, central, and tropical Africa it is well known as a powerful medicine and article of indulgence, and in southern Africa the Hottentots use it for the purpose of intoxication. In Brazil even the native Indians are well acquainted with it, and regale themselves in its use.

From the general use of hemp among the natives of India, Dr. O'Shaughnessy was induced to attentively examine its medicinal properties. He states that when *churrus*, or natural resine, is administered in moderate doses, it produces increase of appetite and great mental cheerfulness, while in excess it causes a peculiar kind of delirium and catalepsy. "At two p.m.," says the learned author, "a grain of the resin of hemp was given to a rheumatic patient; at four p.m. he was very talkative, sang, called loudly for an extra supply of food, and declared himself in perfect health. At six p.m. he was asleep; at eight p.m. he was found insensible, but breathing with perfect regularity. His pulse and skin were natural, and the pupils freely contracted on the approach of light. Happening by chance to lift up the patient's arm, the professional reader will judge of my astonishment when I found it remained in the same posture in which I placed it. It required but a very brief examination of the limbs to find that by the influence of this narcotic the patient had been thrown into the strangest and most extraordinary of all nervous conditions, which so few have seen, and the existence of which so many still discredit—the genuine catalepsy of the nosologist. We raised him to a sitting posture, and placed his arms and limbs in every imaginable attitude. A waxen figure could not be more pliant or more stationary in each position, no matter how contrary to the natural influence of the gravity on the part! To all impressions he was almost insensible."

The author afterwards found that this extraordinary effect of the drug was produced upon other animals as well as man. After a time the effect entirely passes away, and leaves the individual altogether uninjured.

It may be by the use of the hemp that the "fakeers" perform many of those wonderful feats, and thus by dishonest means exercise their influence upon the ignorant and unsuspecting masses of the people.

Since the publication of Dr. O'Shaughnessy's remarks upon the effects of the preparations of hemp, it has been imported and used in this country; and in many cases in which the preparations of opium disagreed, this has been substituted, and generally with great advantage to the patient.

It is needless to enumerate the very many uses to which the fibre of the hemp is now applied; perhaps its most important application in this country is in the manufactory of ropes for ships, etc., and for making the coarse kinds of cloth. The seeds yield by pressure a yellowish kind of oil, which is almost tasteless, but has a disagreeable smell. It is used for burning in lamps in Russia and other countries, and also in the manufactory of soap and some kinds of varnish. Hemp, rags, and old ropes are used for making paper of various kinds. These are reduced to pulp by machinery, the pulp is then spread upon wire-gauze frames, and dried; some kinds of paper thus made are afterwards sized with a solution of glue and alum, which increases the strength of the paper, and to give it a smooth or glossy appearance it is passed between hot polished steel rollers.

R. Deakin, M.D.

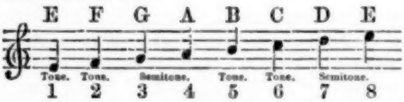
SPORTIVE EXERCISES UPON MUSICAL NOTATION.

IN TWO PARTS.—PART II.

—*—

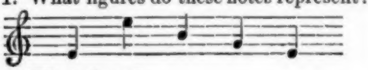
SECTION IV.—THE SCALE.

But there is a regular progression of the notes from E to E (or from any one note to its eighth or octave), which is called the Scale. This scale, which is called the Natural or Diatonic Scale, to distinguish it from another called the Chromatic, is formed of certain tones and semitones, following each other in a wonderfully natural manner.

Beginning at E, the semitones are between the notes G and A, and D and E, the third and fourth, and the seventh and eighth of the scale, thus:—

Let the key-note (the note from which the scale starts) stand for the figure 1. In the present instance, and for the purposes of the next problem, let that note be E; F will represent 2; G, 3; A, 4; B, 5; C, 6; D, 7; and the last, E, 8. Get this well fixed on the mind, and then resolve the following—

Problems upon Section IV.

1. What figures do these notes represent?



2. What these?

3. These?

4. These?

5. These?

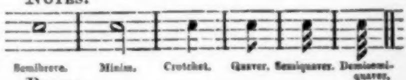
6. These?

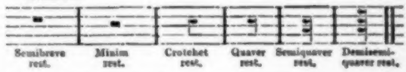
Solutions.

1. 18531; 2. 8798351; 3. 153853251; 4. 78983451; 5. 181813581; 6. 87654321.

SECTION V.—FIGURE, LENGTH, AND RELATIVE VALUE OF NOTES, WITH THEIR RESPECTIVE RESTS.

Notes.

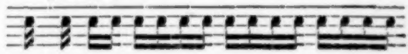


Rests.

1 semibreve in length of time is equal to

2 minims; which are equal to

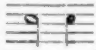
4 crotchets; or

8 quavers; or

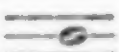
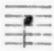
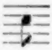


16 semiquavers; or

32 demisemiquavers.

A Dot after a note or rest makes the note or rest half as long again. Example:  is equal to a  minim and a crotchet; or to three crotchets, and so on: is equal to —*i.e.*, a crotchet and quaver rest, etc.

Problems upon Section V.

1. Resolve this semibreve  half into crotchets,  one-fourth into quavers,  and the other fourth into semiquavers, 

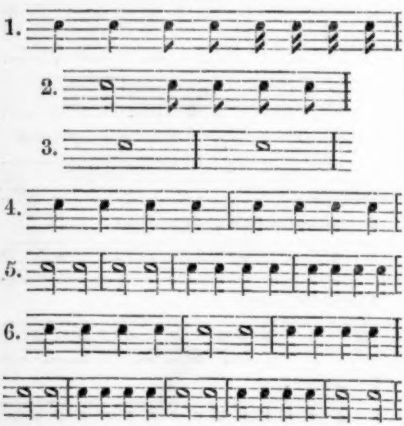
2. Resolve the semibreve half into minims, and the remaining half into quavers.

3. Condense sixty-four demisemiquavers into semibreves. 

4. Condense sixty-four demisemiquavers into crotchets.

5. Condense sixty-four semiquavers into half-minims, and half-crotchets.

6. Condense sixty-four quavers half into crotchets and half into minims.

Solutions.

A Batch of Little Questions upon Section V.

1. To two semibreves, two minims, and two crotchets, how many quavers form an equivalent?

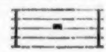
2. While I am singing three semibreves and six minims, how many crotchets might be played?

3. If the length of a psalm-tune be equal to two hundred and fifty-six quavers, what is its length in semibreves?

4. What number of crotchets would represent the length of the psalm spoken of in the previous question?

5. If a semibreve represented the value of a twenty-pound note, what would be the relative value of a semiquaver?

6. How many crotchets might be counted during a semibreve rest? 

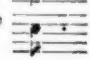
7. What sort of a rest is this, and how many crotchets are to be counted while it is observed? 

8. How many quavers might be counted during a minim rest?

9. How many demisemiquavers might be played during a rest equivalent to two semibreves and one minim?

10. How many semiquavers are equal to a dotted minim?

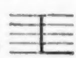
11. How many semiquavers are equal in length to a dotted crotchet? 

12. How many of the same are equal to a dotted quaver? 

Answers.

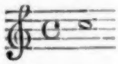
1. Twenty-eight; 2. Twenty-four; 3. Thirty-two; 4. One hundred and twenty-eight; 5. Twenty-five shillings; 6. Four; 7. A minim—two; 8. Four; 9. Eighty; 10. Twelve; 11. Six; 12. Three.

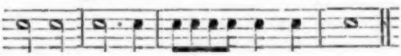
SECTION VI.—TIME AND ITS DIVISIONS.

The Bar, made thus,  divides a musical composition into EQUAL portions of time.

Time is divided into two sorts—COMMON and TRIPLE; each of which is either SIMPLE or COMPOUND; and the character, or sign which denotes it, is placed at the beginning of every composition, after the clef.

SIMPLE common time, when marked thus,  or thus,  denotes that each bar contains one semibreve, or its equivalent. Example:

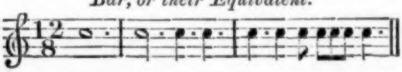
 or, 



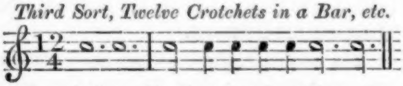
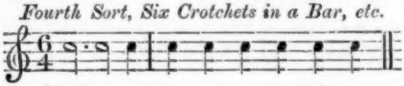
When marked thus,  the bar contains one minim, or its equivalent. Example:

FOUR SORTS OF COMPOUND COMMON TIME EXPLAINED.

First Sort, containing Twelve Quavers in a Bar, or their Equivalent.

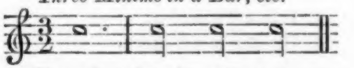


Second Sort, Six Quavers in a Bar, or their Equivalent.

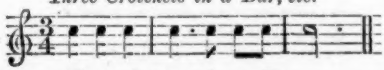
Third Sort, Twelve Crotchets in a Bar, etc.

Fourth Sort, Six Crotchets in a Bar, etc.

[The last two sorts are very seldom used in modern music.]

SIMPLE TRIPLE TIME EXPLAINED.

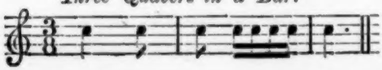
Three Minims in a Bar, etc.

1. 

Three Crotchets in a Bar, etc.

2. 

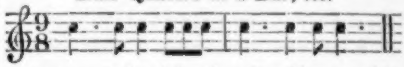
Three Quavers in a Bar.

3. 

COMPOUND TRIPLE TIME EXPLAINED.

Nine Crotchets in a Bar, etc.

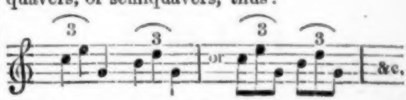
Nine Quavers in a Bar, etc.



[*Compound* triple time is seldom used in modern music.]

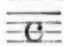
N.B.—The contents of every bar in common time, whether SIMPLE or COMPOUND, may be divided (by beating or counting) into four, or into two equal parts; and in triple time, whether SIMPLE or COMPOUND, into three equal parts.

The figure 3 placed over three crotchets, quavers, or semiquavers, thus:



(which are called triplets), denotes that the three notes are to be played, or sung, in the time of two.

QUESTIONS FOR EXERCISE UPON SECTION VI.

1. How many crotchets, or their equivalents, would be found in a piece of twelve bars marked at its commencement, thus  or thus? 

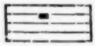
2. A certain psalm-tune was of the length of sixty-four crotchets, and was divided into sixteen bars: what was the signature at the commencement?

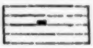
3. A hymn-tune was of the length of thirty-two crotchets, and was divided into sixteen bars: what was the signature?

4. A slow movement was of the length of forty-five minims, and was divided into fifteen bars. In what time was it written?

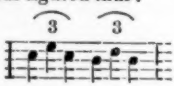
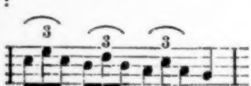
5. Another movement measured one hundred and twenty crotchets, and was divided into forty bars: what signature was found at its beginning?

6. A dance-tune was of the length of forty-eight quavers, and was divided into sixteen bars: what was the signature?

7. If, in the middle of a movement, you saw a rest of this kind  occupying a whole bar, what would you judge the time of the movement to be?

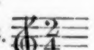
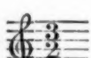
8. If you saw, under similar circumstances, this sign,  what would you presume the time of the movement to be?

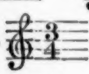
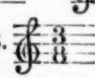
9. If, under similar circumstances, you saw a bar occupied by rests, thus,  what would you judge the time of the movement to be?

10. If, in the middle of a movement, you met with a bar figured thus:

Or thus:

what would you conclude the time of the movement to be?

SOLUTIONS OF QUESTIONS ON SECTION VI.

1. Forty-eight.

2.  3.  4. 

5.  6. 

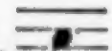
7. Common time; four crotchets in each bar.

8. Common time; two crotchets in each bar.

9. Triple time; three-eighths, *i.e.*, three quavers in each bar.

10. Common time; four crotchets in a bar.

SECTION VII.—SHARPS, FLATS, AND NATURALS.

A SHARP ♯ raises a note half a tone; it makes it by that much acuter in sound. For instance, C,  thus simply written, has a certain sound  (easily ascertainable by touching that key upon the pianoforte, or producing it from a blow-pipe). But if it have a SHARP ♯ placed against it, either in immediate contact or next to the time-signature at the commencement of the movement, it expresses a sound half a tone higher. The two ways in which C ♯ is recognizable are as under:—

1.  2. 

When the SHARP is affixed to the Staff in the first manner, it affects all the C's in the piece; when it is placed as in the second instance, it affects that one note only.

A FLAT ♭ depresses a note half a tone; it makes it by so much a deeper or graver sound.

A NATURAL ♮ contradicts a ♯ or a ♭, and restores a note that had been raised by the ♯, or depressed by the ♭, to its natural tone.

Besides the above marks there are double ♯'s and double ♭'s.

The double ♯ is thus distinguished, ×; it raises a note TWO semitones, *i.e.*, it substitutes D natural for C natural.

The double ♭, thus marked ♭♭, lowers a note two semitones: thus, C natural depressed by a double flat would be B flat, if sought for among the keys of a pianoforte.

REBUSES INTENDED TO RECALL TO MIND THE FORMS AND NAMES OF SHARPS, FLATS, AND NATURALS.

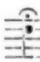
1. Messrs. Dodson and Fogg were addicted to ♯ practice.
2. It is a ♯ morning.
3. Hunger is a ♯ thorn.
4. He fell into the company of ♯ers.
5. This beer has become quite ♭.
6. Fools love ♭tery.
7. She gave him a ♭ denial.
8. He fell ♭ upon the pavement.
9. Leave off affectation, and be ♮.
10. He was of a ♮ly warm disposition.

11. Its ♮ colour is red.

12. It was very ♮ that he should be offended.

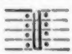
(The above are so very simple, that no solutions are needed; but it is recommended to young students to make, upon the model of the foregoing, a number of other Rebuses, both for their own improvement, and for the amusement of those younger and less proficient than themselves.)

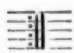
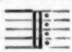
SECTION VIII.—VARIOUS OTHER MARKS.

The PAUSE  (or)  renders the NOTE longer at PLEASURE; and, in certain cases, the composer expects some embellishments from the performer; but the PAUSE on a rest 𝄐 only lengthens AT PLEASURE the SILENCE.

The SIGN or REPEAT 𝄋 is a reference to a passage, or strain, to which the performer is to return: the Italian words AL SEGNO, or DAL SEGNO, denote such a return.

The double bar  marks the end of a strain; or the conclusion of a piece.

The DOTTED bars  (or)  denote the repeat of the foregoing and following strain.

When the bars are marked thus,  or thus,  then the strain only on the side of the DOTS is to be repeated.

The BRACE { ties together the two staves used by the performer upon the pianoforte or organ. It is used to connect all the vocal parts in a score, but its chief use is as in the annexed example.

The TURN  is an embellishment, the nature of which your preceptor will explain to you. It is sufficient here that you should know its name and form.

The same remarks apply to the SHAKE, or TRILL.

DIM. (*diminuendo*) 𝆓 indicates that the sound is to be decreased.

CRES. (*crescendo*) 𝆒, that the sound is to be increased.

The TIE, or SLUR, ⁀, placed over a few or many notes, implies that they are to be slurred over, or sung *legato, i.e.*, connectedly.

p, or PIA., means PIANO, and implies that the passage against which it is placed is to be played or sung softly. *p p* (*pianissimo*), means very softly. *f* and *f f* (*forte, fortissimo*), signify loud and very loud.

REBUSES UPON SECTION VIII.

1. In the midst of his harangue he came to a 𝄐.

2. We should always 𝄐 before any great attempt.

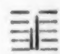
3. There was an awful 𝄐.

4. Why do you 𝄐?

5. They did not observe the preconcerted 𝄋, and we were obliged to 𝄋 it.

6. These were to be regarded as 𝄋 𝄋 of the times.

7. They gave no 𝄋 𝄋 of yielding.

8. I was obliged, for my own protection, to put up a 

9. The turnpike was splashed over with clay, and reminded one of a 

10. Courage! let us { ourselves to the work.

11. You should be happy now that your new *p f* has arrived safely.

12. "Oh, she can 𝆗 and 𝆗, and still go on."—*Shakspeare.*

13. 𝆗 again Whittington!

14. Young Phipps paid great attention to the arrangement of his ⁀.

15. Their misbehaviour was ⁀red over.

16. The finances of Falkenburg were in a constant 𝆓.

17. Henry is a rising man; his fortunes are on the 𝆒.

W. NEWMAN.

MY BIRD—THE SISKIN.

OTHER people are allowed to vaunt the merits of their favourites, and therefore I will take the liberty of saying a word in favour of mine.

Of all the small cage-birds I have ever kept, which has proved the most pleasing and attractive to me and mine?

Not the canary; he is too loud and shrill, and insists on taking the lead in every conversation, which is a breach of good manners. Not the chaffinch; too wild and monotonous. Not the bullfinch; too melancholy, and rather given to sulking. Not the goldfinch; pretty, but egotistical, requiring to be made a spoiled bird of, to show itself to the best advantage, and needing severe discipline to urge it to exert its intellectual faculties. The linnet, when really tame, is an engaging and modest bird—so modest, in fact, as to make you doubt of its abilities. The pretty little tits are carnivorous furies, cannibals who will feast on a fellow-prisoner. The nightingale, like other great singers, is apt to give himself airs, and is also troublesomely particular in respect to his diet. The same remark is more or less applicable to all the soft-billed insectivorous songsters. To keep a robin in a cage permanently is out of the question. A caged skylark gives me little pleasure. With the blackbird and the thrush, both sweet minstrels of the grove, we have taken leave of small cage-birds, and are half-way on the road which leads to large ones. An ornithological rule-of-three would give, "As the canary is to the blackbird (in point of size), so is the thrush to the magpie or the jay. Size also is an objection to the greenfinch, and to the hawfinch especially; both of them caged suggest the idea of small fowl put up to fatten; they make us think more of roast meat than of music. The brambling, handsome and tameable, is long-legged and far from eloquent. The buntings are, for the most part, either stupid like the ortolan, or savagely wild like the snow-bunting. The cardinal grossbeak, or Virginian nightingale, is shy, vulgar-toned, and loud. The Paddy-bird, though tame and handsome, is as wearisome as the chaffinch, with his everlasting and unvarying chant. Little avidavats, waxbills, etc., are simply good to bring sorrow to their keeper; they breathe the air of our northern winter, and they die. But, in explanation, be it understood that the above-named birds are not meant to be sweepingly and universally condemned, nor to be excommunicated from civilized aviaries. A kind and attentive master or mistress will develop their native merits and subdue their natural defects, to a certain extent, that is to say, and with individuals superior to the common run; for amongst birds, as in the human race, the capacity and the temper of individuals vary greatly. Every one to his taste, therefore. My taste is the siskin, or aberdevine, the *Fringilla spinus* of ornithologists (perhaps because its long sharp beak resembles a thorn, or *spinus*), the *zeisig* of German fanciers, and the *tarin* or *thérin* of the French.

The siskin, while exempt from the faults of most other cage-birds, unites in itself many of their merits. Its small size (less than that of the canary) heightens its prettiness. The character of its plumage may be briefly expressed by the adjective "neat." In the male, shades of yellow, greenish-gray, and black are harmoniously blended and contrasted; the female, who wears the same hues, is decorated with marked stripes of black on the lower part of her person. Its song, instead of a head-splitting din, is a soft, gentle warble, which may be heard within-doors without pain. True, the cha-

racter of the whole strain approaches to that of the swallow's subdued twittering on a summer's morn, and at the close there occurs a prolonged note, which critics might call a little cracked or reedy; but, to my taste, it is a defect on the right side. The clear, bell-like tones of the nightingale and thrush families, which ring and make their way through the densest foliage, and the penetrating accents of the lark, which reach us from heights in open space at which the human voice could scarcely be audible below, are not agreeable to, nor supportable by, every ear nor every head in closed apartments. In proof of which, those birds, when in song, are mostly hung outside the owner's house or cottage.

When the siskin appears amongst us in October, it does not obtrude itself on the notice of the every-day traveller on the highway-road, but must be sought for in secluded gardens and shrubberies, on the skirts of the wood, and in the alder copse. Far from towns, it is the forester's bird; he watches its antics amongst the branches of the fir-trees, and rejoices that his stacks of fire-wood are well piled and sheltered from the rain; for winter is coming, and with the aid of his store he will weather its storms as gaily as the nimble siskin. The arrival of the siskin fills the imagination with images of Scandinavian pine-forests, moss-grown rocks, waterfalls, and thickets of hazel and birch.

It is a satisfaction to find one's preferences confirmed by a congenial opinion, and therefore I cite, *verbatim* and *spellatim*, from the "Bird-Fancier's (*sic*) Recreation," London, without date, but printed for T. Ward, and sold at his house at the Bird-cage on Stamford Hill, Tottenham Road, a quite short account of the aberdevine:—

"This is a verry pretty mery Bird, and is much the Colour and Bigness of a grey Canary-Bird, they don't breed in these Parts, nor can I give you any Account where they breed, but I believe they come from the North, being commonly catch'd here in the Winter; they frequent here the Alder Trees by the River side, and are so to be catch'd as we do Linnets or Goldfinches, they feed upon the same Seed as the Chaffinches or Linnets, but they love the white Seed; they are a mery Bird, and the Colour of a Canary-Bird, only the Cock has a black Spot upon his Head, and a little black under his throat."

They are a very pretty, merry bird, and that is the main reason why I patronize them in these pages, and love them at home. No bird becomes reconciled to confinement more cheerfully and contentedly, or in a shorter time after being caught; notwithstanding that, in a wild state, it manifests no great confidence in man by entering houses, as the robin does. But siskins are philosophers. When they find themselves prisoners, with plenty to eat and drink, instead of moping and pining, they say to themselves, "What can't be cured, must be endured," and make themselves at once easy and comfortable in their new house and with their new friends. From that moment they become as teachable as any little bird can be; nay, even jealous of any other little bird whom you may try to teach in their presence. Of three hen siskins, wild from the copse only last December, I gave two away to two of my friends, retain- the third myself. No. 1 has long since (this is written February 15th) learnt to draw a a little cart *up* an inclined plane, by means of a string. No. 2 insists on partaking of all the family meals, and puts her head through the wires of her cage, begging to be let out, as soon as she sees the table-cloth laid; she will perch upon her owner's fore-finger, and take a seed held between his lips. No. 3, my own, has not received so elaborate an education, for want of leisure on the part of her instructor; but if I open her cage-door and call her, she will come flying to stand on my open hand, and enjoy a treat of hemp-seed, which she expects, and almost

begs to be previously cracked, to aid her somewhat feeble beak, and will peck my fingers for more when the ration is done. She would instantly drive away any fresh favourite who dared to take the same familiarities; she is therefore obliged to be caged while I carry about the room, perched on an ear of millet, a male siskin caught in January, and now rewarding me with a song while I record his tameness.

Siskins may be taught their tricks without the employment of privation or cruelty. The whole secret lies in their being very greedy birds, epicures also, above all things fond of hempseed, and nearly as much so of the seeds of the alder-tree, likewise entertaining a great relish for the seeds of the poppy (the mawseed of the shops), which is grown on the Continent to extract salad-oil from. Siskins eat more than many of their larger feathered friends.

To train them to personal intimacy with yourself, you have only to let your birds become just a little hungry. Lesson 1: In the morning, before they have breakfasted, offer a single hempseed between your finger and thumb; after some hesitation and dallying, it will be taken; repeat the lesson till the pupil is perfect. Lesson 2: Substitute your lips for your finger and thumb. Lesson 3: Repeat the two previous lessons, but in both cases hold the seed so tight that the bird has to tug and pull, and exert all its strength before it can obtain possession of the morsel. Lesson 4: Open the cage-door, and let the bird *step* out of the cage upon your fingers, to eat crushed hempseed upon your open palm. If a well-behaved bird, it ought to step back into its cage again; but if it flies into the open room, by no means catch it to restore it to its home, but let it find its way back by itself. People generally suppose it to be a punishment to a bird to cage it, and it may be so in many cases; but you may punish a siskin that has not been properly obedient by shutting it out of its cage—by closing its own wiry door against it, just as an ill-behaved boy is turned out into the back-yard to meditate. When hunger and thirst begin to be felt, the penitent siskin will make very amusing efforts to get in, will try to force a passage, or to discover

The Siskin.

the secret of the cruel man who made well-stored bird-cages so hard to enter. If a piece of string or tape happen to be tied on or near the door, the persevering little creature will endeavour to untie it, with the idea that it is *that* which prevents its entrance. A siskin might be more easily taught to break into a cage, than to break out of it; because, if its larder is well supplied within, it has no motive to the commission of the converse of burglary. Lesson 5: Make your bird *fly* from its cage to alight on your hand, wherever you may be. After this elementary course of instruction, your siskin will be ready for whatever branches of education you may destine his future career to embrace.

The dragging of chariots and the drawing of water, which appear so wonderful, may also be taught without unkindness. The feats are nothing more than an easy application of the pupil's natural address and cleverness. The siskin is born (or hatched) a mountebank, a posture-master, a fearless acrobat, a clown full of whim and humour. Of its own accord it likes to do things in a way that would be difficult for many other birds, and impossible for vulgar cocks and hens. For instance, it will drink in a perpendicular position, with its head downwards, and hanging by its legs. It will sleep clinging uncomfortably to the wires, instead of sitting on a convenient perch. It will run along the sides and top of its cage, like a fly upon a wall or a ceiling. Throwing somersets is with it a favourite amusement. Its feet are also hands, which it utilizes, if not to the extent, at least after the manner of parrots. It eats suspended beneath a branch as easily as upon the branch. It has no dislike to swinging itself on an ear of millet at the end of a string; if you give it the chance, it will hold to a perch with one foot, while it steadies and retains the ear of millet with the other. Talents such as these only need a direction to be given to them.

Therefore, mix no hempseed with your bird's daily food of canaryseed and millet, but place the cart to be dragged, laden with hempseed, on a *flat* surface, outside the cage, where the bird can reach it by putting its head through a hole in the wirework, such as is usually left for drinking. When he has eaten a few grains in this way, put the cart out of his reach, but with a bit of string fastened to it, the end of which string is in the cage. As his appetite for hempseed is sharpened, he will not be long in finding out that by pulling the string with his bill, he can draw the cart to him and enjoy its contents. He may be made to repeat this manœuvre for a day or two, when the next step in his training may be taken by placing the cart on an inclined plane, sloping *from* him. Of course, as fast as he draws the cart towards him, it will run back again by its own weight. After a few tantalizing disappointments, he will adopt the expedient of holding down the string with his foot, while he either draws the cart still nearer, or regales himself with the earnings of his ingenuity. By the same proceeding, he may be taught to draw water from a reservoir, by means of a small bucket; but, to avoid the possibility of death from thirst through any derangement of the apparatus, it is more humane to leave the *necessaries* of life always within reach, without having to be worked for.

Siskins are fond of splashing themselves with water, and should be allowed to do so twice a week at least, in some shallow, open dish.

As in the linnet the bill assumes a bluish tinge, so in the siskin it becomes tipped with deeper black on the upper mandible, at the approach of the singing season. If a pair, male and female, be kept in the same cage, they should be allowed to select their own mates, otherwise, the ill-assorted couple may terminate their union by a deadly quarrel.

E. S. Dixon.

THE BURYING-BEETLES, OR SEXTONS.

THAT there are many wonderful things to be learnt by the careful and persevering study of the habits, instincts, and metamorphoses of insects, the untiring watchfulness of a Reaumur, a Bonnet, or a Swammerdam have sufficiently proved (if such proof were needed), in the curious and interesting records they have left concerning insect life. But these records were of necessity not entirely complete,

Necrophorus ruspator. 1, Female; 2, Male.

and the question is, whether, from the valuable data furnished by great naturalists, we have not been induced, in some cases, to amplify over picturesquely—filling up *lacunæ* by what appeared to us undeniable inferences, rather than with well-ascertained additional facts. The additional facts still desirable are, perhaps, very hard to get at; but until we get them we must rest satisfied with an incomplete picture, and, above all, we must not attempt to finish it from imaginary references, however plausible.

These remarks have reference more immediately to the habits and instincts of a group of our native *Coleoptera*, popularly known as the burying-beetles, as we find those insects described in the most modern entomological works, both popular and scientific. Among the earliest of the writers who describe the peculiar habits of the burying-beetles with great minuteness, was M. Gleditsch, in his "Recreations of Natural History," published at Halle, in 1765. This account has been recently quoted by Messrs. Kirby and Spence, in one of the best and most trustworthy entomological works in the language, and also by Mr. Westwood, in his "Modern Classification of Insects." It is as follows:—"M. Gleditsch had often remarked that dead moles, when laid upon the ground, especially if upon loose earth, were almost sure to disappear in the course of two or three days, often in twelve hours. To ascertain the cause, he placed a dead mole upon one of the beds of his garden. It had vanished by the third morning; and on digging where it had been laid, he found it buried to the depth of three inches, and under it four beetles, which seemed to have been the agents in this singular inhumation. Not perceiving anything particular in the mole, he buried it again, and on examining it at the end of six days, he found it swarming with maggots, apparently the issue of the beetles, which M. Gleditsch now naturally concluded had buried the carcase for the food of their future young." This passage has been repeated by one entomological writer after another without further investigation. It is true that M. Gleditsch further states, that in order to convince himself of the truth of his

suppositions, he placed some beetles of this kind in a glass vessel, in which was a tolerably deep layer of earth, and upon the earth he placed in succession several small dead animals, all of which were, in due course, *buried*. The *modus operandi* is most graphically and minutely described. Here the earth appeared to be forced from beneath the body, forming a cavity into which it eventually dropped, while the little rampart of extracted earth was eventually filled in over the body. The result of this experiment was, that in fifty days four beetles had buried, in the very small space of earth allotted to them, twelve carcases of frogs, small birds, etc.

This is a very categorical statement, and as such it has been copied and recopied, passing from the pages of one entomological writer to those of another, over and over again, without further examination. This is the great defect of compilations. If well done, they often convey a great amount of information in an agreeable form, collected and methodized from sources difficult of access to general readers; but compilers are often compelled to take such statements upon trust, after some brief examination of the apparent trustworthiness of their informant.

It is very difficult to get up a strong feeling of suspicion against such a categorical statement as that of M. Gleditsch, and difficult to imagine how he could be deceived. Still there are some little inaccuracies, which might lead one to infer that others also might have crept into his graphic narration. He states, for instance, that he observed the mole, after it was buried, to be swarming with *maggots*. Now the larvæ of this class of beetles are very different from maggots, being furnished with distinct, well-developed pectoral legs, while "maggots" are entirely legless. If, therefore, he uses the term advisedly, and they were really maggots that he observed, they were certainly the offspring of certain flies, and not of any kind of beetles. The larvæ in question may have been, and probably were, the larvæ of the burying-beetles, and not maggots; but this proves a certain amount of inaccuracy of description, which might lead to the supposition that other inaccuracies or inadvertencies may probably occur in other parts of the description, which would tend to invalidate the whole of it. The time occupied in the burying—fifty days—is also strange, as the operation is generally performed in as many hours, and seldom exceeds three or four days.

It must be stated, however, that recent entomologists have made similar statements regarding the habits of the burying-beetles, especially a very eminent one, who writes under the pseudonym of "Rusticus." This writer describes the habits of these beetles as M. Gleditsch does, but with a graphic power far surpassing that of his predecessor, at the same time giving to his account all that minuteness of detail which generally carries with it the appearance of a description made from Nature, and in presence of the facts described. Wishing, however, to witness these interesting facts myself, and being determined to catch the insect sextons in the very act of prosecuting their operations in the way of interments of this kind, I have on many occasions placed the carcases of small animals, as mice, frogs, birds, lizards, etc., in different parts of my garden, but without ever on a single occasion being gratified by witnessing such results as those described by M. Gleditsch and several recent writers. It is true that I almost invariably, at the proper season, found burying-beetles *beneath* the remains so placed, portions of which they appeared to take into the burrows where their eggs were deposited; but I could perceive nothing like the regular process of interment so minutely described by more fortunate observers. In short, so far as my own observations go (but without in any way impugning the good faith of others), I must acknowledge that I was forced, at the close of a pretty long

and careful trial, in which all the evidence was most carefully sifted, to avail myself of a Scottish form of verdict—"Not proven."

I have since consulted Mr. F. Smith, of the British Museum, upon this interesting point of beetle economy. He is one of the most active and intelligent entomologists of the day, and gets his facts fresh out of the fields, instead of extracting them cut and dried from the book-shelves of his library. He informs me that his experience accords with my own; that he is in the habit, every season, of collecting this class of beetles (among others), and that to facilitate the procuring of a plentiful supply of specimens, he "baits" for them after a regular manner, according to the species he is seeking. For some he baits with a dead frog or lizard, for others with some small animal, as a mouse or mole; for others with dead fish, etc. He tells me that his baits seldom or never fail; but that in all his experience among the *Necrophora*, he never witnessed a single instance of an evident case of regular "interment" taking place. They doubtless burrow for the purpose of depositing their eggs, and are found beneath the remains of the kind described, portions of which they carry off down their subterraneous passages, to serve for the food of the larvæ; or, in some cases, the eggs are deposited within the carcases themselves, which are rapidly consumed by the larvæ. It is thus that they perform the part of scavengers on land, as the shrimp and lobster tribe do in the ocean, preserving the air from the pollution of effluvia emitted by decayed animal matter.

It is very probable that in cases where the carcase was small, as in the case of a mouse, frog, or small bird, that instead of attempting to carry it piecemeal down the burrow to the underground nest, where the eggs had been deposited, the beetle may have removed the earth from beneath so as to let the whole of the body down to the deposit of eggs, and afterwards covering it up as described. Mr. Smith, however, informs me that, although moles are said by many authors to have been interred in this manner, he has often "baited" with rats of not greater dimensions than a mole, and yet never found any attempt at interment. He found beetles concealed under the body during the day-time, their principal work being carried on in the night, when the flesh was evidently carried off piecemeal down the burrows formed by these beetles.

It is conceivable that the accounts of authors previously referred to may have been founded upon mistakes, occurring in the following manner:—A frog or field-mouse may have crept into some slight hollow to die, and there have been discovered with the beetles beneath it. A curious observer may have noticed the circumstance with some interest; and visiting the spot some time afterwards, and finding that the carcase had entirely disappeared, may have come to the conclusion that, inasmuch as it lay in the hollow place before, it had since been actually interred, and that the hollow was but the commencement of a regular grave, the inhumation having afterwards proceeded to completion. It is true that M. Gleditsch asserts that he *dug* on such a spot to ascertain what had become of the object that had disappeared, and found it some inches below the surface; while others have made searching observations, the good faith of which one has no right to doubt. But to solve the question, let any of our readers try the experiment for themselves. There is no dearth of the beetles, for they have a mighty work to perform in cleansing the earth of its dead, and prevent it from becoming a vast charnel-house; and where decaying matter is to be found polluting the sweetness of the air, there their keen sense of smell will quickly conduct them, and its rapid removal by the insatiate mandibles of their larvæ will soon take place. Let, therefore, the experiment be tried carefully and watchfully by several observers together, so that each may test the

accuracy of the others method of investigation; and in this way we shall clear up the question of the burying capacities of this valuable race of beetles, which for the present I shall be content to call "scavengers," rather than "sextons."

There are several British species, of which the following lines will contain a brief summary. The species represented at the head of the article is *Necrophorus ruspator*, a kind plentifully distributed. The one with the expanded wings is a female, the other a male specimen, in which it may be observed that the brushes of the fore legs, which are used in burrowing for the purpose of forming a passage to the subterraneous nest or egg deposit, are stronger and larger than in the female, which proves that the male does his full portion of the work of building, or rather excavating, the nursery for the young.

Necrophorus germanicus is the largest British species of the burying-beetle tribe; it is entirely black, and nearly twice the size of the species engraved. It is very rare, being seldom seen except on the coast, the only specimen recently captured having been taken near Hastings by Mr. Heales. The Continental specimens of this species are considerably larger than the British. The next species, *N. humator*, is much smaller, but still entirely black, with the exception of orange tips to the antennæ, and a narrow orange border to the wing-cases. *N. vestigator* is the first species that exhibits the characteristic orange-red bars across the wing-cases, similar to those delineated in our illustration. *N. vestigator* is extremely local, but where it occurs it is plentiful enough. In Suffolk, for instance, it is found abundantly, in places where the most common of all the species is scarcely ever seen. It may be distinguished from *ruspator* by the golden hairs which fringe the edges of the thorax, and also by the form of the thorax, which is narrowed posteriorly. *N. interruptus* is very like *N. ruspator*, but may be distinguished by the orange fringe of silky hairs on the exposed joints of the abdomen. This species is very rare, and at present has only been found at Southend. Mr. Smith discovered it under a dead adder, which had been crushed in the road; and baiting for it with young adders, which he procured and killed for the purpose, secured other specimens; but during these captures he never observed any attempt to bury the carcases of the adders so placed. *N. ruspator*, the species engraved, has these hairs entirely black. *N. mortuum* is the smallest of the red-barred species, but varies very much in size, some being not half an inch in length and others nearly an inch. The large specimens resemble *ruspator*, but are easily distinguished from that species by the absence of the orange tip of the clubs of the antennæ, which in *N. mortuum* are entirely black. *N. vespillo* may be distinguished from either of these species by the golden hair of the exposed joints of the abdomen, and from *N. vestigator* (which in this respect it resembles) by the bowed form of the middle portion of the hind legs; and this last is the typical and most common species.

The genus *Necrodes* is also composed of beetles of this tribe of carrion feeders. Among the species *Necrodes littoralis*, with its fluted wing-cases and the greatly-enlarged thighs of the hind legs of the males is noticeable. This kind is found in large numbers in the carcases of drowned animals lying on the banks of the Thames, of which river it seems to have established itself in the office of chief scavenger. The genus *Silpha* also comprises a closely-allied group of beetles; among these *S. thoracica*, with its dull black wings, and thorax of a velvety texture and rich ruddy brown colour, is at once remarkable. *S. quadripunctata* is very distinct in form and habit, and will doubtless be eventually separated from the genus to which it is now assigned; the wings are polished, and of a light ochreous tone, with four black spots; and it is said to feed upon the living larvæ

of butterflies and moths, seeking them especially among the foliage of the oak, from the branches of which it is frequently shaken by collectors.

Some of the exotic species of the burying-beetles are very much larger than the European kinds, especially the *Necrophorus grandis* of North America, which is four times as large as the *N. ruspator* engraved above, but so like it in form and markings that it might be taken for a magnificent specimen of that species. The *Necrodes giganteus*, found near Sarawak, in Borneo, is very much larger than any of our European *Necrodes*, and is very remarkable on account of the different character of the thorax in the two sexes, that of the male being light brown and velvety in texture, while that of the female is darker brown and brightly polished.

A peculiarity of this kind of beetle which I have not referred to, is the squeaking noise which they are enabled to make by rubbing the joints of the abdomen against the inside of the wing-cases. When held in the closed hand near the ear, this sound appears as loud as the squeaking of a mouse. They are also enabled to emit a fœtid smell, which serves them as a defence, and which is very permanent on any substance which has been affected by it.

Several writers have mentioned the immense swarms of beetles belonging to this class, which are sometimes observed in Russian graveyards.

H. Noel Humphreys.

MICROSCOPICAL POND-LORE.

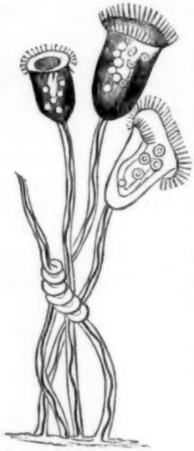
Hundreds of persons now purchase microscopes from the force of imitation, and a laudable desire to obtain an insight into the wonders of creative skill, which are, perhaps, more astounding in the apparently boundless regions of the minute, than even in the unfathomable depths of celestial space; but they are apt to be discouraged by the technical difficulties in the way of collecting and preparing materials for investigation or research.

"The Wonders of a Stagnant Pool," by Mr. Tuffen West, in a former number, will lead many to such small patches of tranquil water, and we now propose to notice a few of the interesting objects which a beginner can easily find. We will take the result of an actual experiment, made on a rather cold, clear, January morning, which had been preceded by one or two days of rather mild weather for the season, but which had not been warm enough to call forth the mass of life hat makes its appearance in early spring. The pond selected was a small one, at the back of St. Alban's Villas, Highgate Rise, and which had proved a good hunting-ground in the summer of the previous year. It lies in a high, airy situation, and a pond so placed is always promising to the microscopic naturalist.

On reaching its margin, it was plain that vegetable life was still in abeyance, so far as related to the principal plants which delight in such localities; but there was a green mass floating in the water, shining in the sunlight, like entangled skeins of silk. This afforded a tolerably certain prospect of microscopic game, and accordingly it was hooked up, and small portions put into two wide-mouthed, two-drachm bottles, which were filled up with the pond-water and carried home.

A word here about bottles. Larger sizes are absolutely necessary, for many purposes; but a great deal is to be done with the small size specified. They have the advantage of

occupying little room, and, when made of moulded glass, of being so strong that a dozen of them may be carried in the pocket, and with little chance of breakage.



Vorticella convallaria. A group of three, with the spirally deflected pedicle of a fourth.—*Pritchard.*

Returning home, a very little piece of the green mass, which consisted of confervoid plants, was placed in a cell formed by cementing a glass ring, such as opticians sell for mounting specimens, on an ordinary glass slide. The cell was then filled with the pond-water, and one of the pieces of round thin glass used in covering objects, placed over it, and pressed down gently, with a piece of blotting-paper to remove the superfluous moisture. When a cell is thus closed, the cover is retained by the action of capillary force, and may be turned upside down without spilling its contents. Such cells are very convenient for examining moderate-sized water creatures, which require more room than can be given in the live-box, and will hold what seems under the microscope a little forest of vegetation. They are handy for polyps, young tadpoles, worms, etc., etc., and a convenient size is made by employing glass rings of about three-quarters of an inch in diameter, and one-twelfth of an inch thick. As they are only intended to hold water, they may be fastened to the slide with shellac dissolved in pyroligneous ether.

Vorticella, with posterior circlet of cilia in process of separation, 300 linear. —*Stein.*

Vorticella microstoma, showing alimentary tube, ciliated mouth, and formation of a yemma at the base, 300 linear.—*Stein.*

To return to our findings, they consisted chiefly of the *Euglena* described by Mr. Tuffen West in the article already alluded to, but without their tails. Their curious rolling way of swimming and extraordinary changes of shape, were enough to bewilder anybody inclined to take them for plants, and at the same time to base any arguments upon the sort of motions supposed to be characteristic of animal life. But there were also a few of the common wheel animalcules, *Rotifer vulgaris*, a few *Vorticella*, with and without stalks, a Cyclops, which was accidentally lost, a fine *Closterium lunula*, and a swarm of *Diatomacea* of the boat shape, whose way of swimming is well worth notice, as it often presents puzzling peculiarities, the cause of which is unknown. Having taken a general view of the various matters in the cell-slide, with a low power—two-thirds reduced by an erector, to from 20 to 30 linear, and, with the second eye-piece for objects, near the surface, brought up to 60 or 80—a Rotifer and some Vorticellæ were placed, with a very minute piece

Vorticella in process of self-division. A new frontal wreath in formation in each of the semi-lunar spaces.

of the weed on which they were found in the live-box. The wheel animalcule was rathe obstinate, and for some time would not assume

Vorticella microstoma, in process of encystment, 300 linear; in the last the inclosing tunic is plainly developed.—*Stein.*

her well-known elongated shape, preferring to keep herself in a more globular form. Viewed under a Smith and Beck's two-thirds object-glass (without the erector), and using the three eye-pieces and draw-tube, which afford a range of from 60 to 300 diameters, it was easy to see the curious stomach in a state of commotion, and make out portions of the wonderful mechanism by which the food is ground up, or, as it may be better described, clawed to pieces; and when the creature chose to put out its sliding, telescope tail at one end, and its so-called wheels at the other, its appearance was so totally unlike its previous aspect that if the changes had not occurred under the eye, no one would have believed it to be the same. The principal points to be observed about this Rotifer are the motion of the cilia, giving the appearance of rotating wheels; the thrusting in and out both head and tail; the use of the latter for a kind of wooden-legged progression; the movements of the muscular stomach, or gizzard,* which lies a little below the head, and is conspicuous from its circular form with what looks like a crop in it; and the presence of eggs, which occur lower down on either side of the intestinal canal.

* This organ has usually been taken for a gizzard, but Mr. Gosse, in an elaborate paper, read before the Royal Society, vindicates its claims to be considered a *mouth.*

Many of the Rotifers are much more beautiful than this, and in some the red eyes are brilliant objects; but the *Rotifer vulgaris* is an excellent representative of the family to begin with, as it is universally found in ponds and cisterns. Unlike most of their fellow-citizens of the so-called infusorial kingdom, they have been gainers by scientific investigation; and while others have often been degraded in the scale of being, and, in many instances, reduced in rank from the animal to the vegetable world, the Rotifers have been elevated to the *Annulata*, and established as first cousins of the worms.

The Rotifers, especially the common sort, are remarkable for their tenacity of life, and are said to have been revived, after having been dried for years, by simply moistening them with water. In considering the physiological bearings of this curious property, the reader should remember what Humboldt tells us in his "Views of Nature," that "the crocodile in the Llanos of Venezuela, the land and water tortoises of the Orinoco, and the colossal boa, and many of the smaller species of serpents, lie torpid and motionless in the hardened ground throughout the hot and dry season of the year."*

Rotifer vulgaris.— A, mouth, or gizzard; B, contractile vesicle. — *Micrographic Dictionary.*
N.B.—When the cilia or tail part are retracted, and the body shortened, the creature assumes an obtuse oval form.

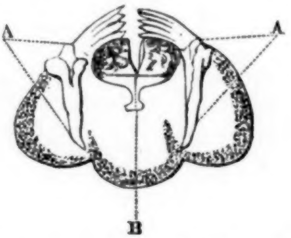
In the Rotifers a specialization of organs and functions marks their rank in creation, and the gizzard, before spoken of, is a most elaborate mechanism, very difficult to describe; but its main principle is the action of toothed hammers worked by powerful muscles, which pre-

* "Views of Nature," Bohn's Edition, p. 243.

sent some affinities with those of the higher animals. They exhibit a division of the sexes, but whether the husbands and wives cherish sentiments of affection is unknown; and, notwithstanding the cleverness of their motions, and the possession of a nervous system, their understanding is probably of a very limited capacity.

The males are much less often found than the females, from which they differ considerably—facts which may account for their having been unknown up to a very recent period. Mr. Gosse, who has devoted great attention to this subject, speaks of the "absolute and universal atrophy of the digestive system in male Rotifera." He adds, "the duration of life in the male is always very brief. I have never been able to preserve one alive for twenty-four hours." Their functions are soon performed; "hence we can understand the lack of the nutritive organism."

A sketch is appended of the mouth or gizzard of the *Notommata clavulata*, from a



Mouth or Gizzard (*mastax*) of Notommata clavulata.—A, hammers (*mallei*), each divided into a handle (*manubrium*), and a hook (*uncus*); B, the anvil (*incus*), formed of two portions moving laterally, called branches (*rami*), and a *fulcrum*.—*Gosse.*

drawing of Mr. Gosse, published in the "Philosophical Transactions," and which will serve to explain this curious organ, the precise structure of which differs in each species, although the principle is usually the same—that of teethed hammers tearing up the food.

We might fill a volume about the Rotifers, but the Vorticellæ are waiting, and we must turn our attention to these elegant flower-like, cup-shaped bodies, with fringes of vibrating cilia, and the slender stalks from which they seem to grow, and which they contract and dart out with an energetic motion. The Vorticella family is far below the Rotifers in natural-history dignity, but they afford some of the most beautiful objects for the microscope, and are physiologically remarkable for the changes which they undergo. At a certain stage of their existence they leave their stalk, and become "encysted," as it is called—that is, they envelope themselves in a bag. They also appear in what are called *acineta* and *actinophrys* forms, with star-like rays projecting from their disc. Our bottles contained Vorticellæ with and without stalks, some solitary, and others growing in groups. A fine specimen in the stalkless state afforded much amusement. After viewing him with a power of 100 linear, in the ordinary way, by light transmitted from the mirror beneath the stage, we moved the live-box by means of the revolving plate attached to the stage, so as to bring his circle of cilia on the right hand, and in a vertical position. Then, throwing a bright light upon the mirror, and turning it so as to reflect a very slanting pencil of rays through the body of the creature, a very charming sight appeared. By this arrangement no light reached the eye except what had passed through the Vorticella, which, so lit up, looked like a luminous cup formed of pearls and coloured gems, standing on a black ground. As each cilium moved, its bright surface flashed in the light for a fraction of a second, like a sabre glancing in the sunshine, and

Vorticella microstoma, the encysted animal protruding through a supposed rupture of the tunic.

then vanished in the gloom; one after another the tiny blades caught the gleam, making a circle of brilliant sparks of variegated light. A lady who witnessed the performance com-

Encysted Vorticella, showing the obliteration of special organs by the advancement of the process.—*Pritchard.*

pared it to that of street jugglers throwing up and catching a succession of golden balls, and called the Vorticella a conjuror with coloured flames.

Before leaving the Vorticella, we must say a few words on the motion of *cilia*. These interesting appendages are very common concomitants of animal life, and give likewise motion to many vegetable forms. By what power they move no one knows; but it is not *muscular*, or it would not be exhibited by the vegetable kingdom. It is affirmed not to be affected by electricity, or by poisons which do not damage the tissue from which it springs, and the motion sometimes continues long after death. The authors of the "Micrographic Dictionary" tell us, "cilia are found in all the vertebrata and the invertebrata, excluding the crustacea, arachnida, and insecta." In man they occur in what is called the *ciliated epithelium*, or membrane lining the larynx, trachea, nose, and other cavities, where their action takes place without our knowledge or control. In the vegetable world their movements are of course involuntary, and probably they are so in many of the infusoria; but they nevertheless are the organs of motion in creatures sufficiently high in the animal scale—like the Rotifers, for example—to be apparently under the control of something like a will.

The last denizen of our bottles we shall mention is the *Closterium lunula*, or beautiful crescent, moon-shaped, transparent cell, nearly filled with the emerald-green vegetable substance called *Chlorophyll.* These exquisite objects were at one time supposed to belong to the animal kingdom; but now, with their fellow Desmids (*Desmidiæ*), they are regarded as among the lower forms of vegetable life. They move through the water with a graceful, dignified sort of motion, produced no one knows how; for the authors of the "Micrographic Dictionary," in the new edition of that work, distinctly deny the ciliary theory which Mr. Osborne puts forth. The one before us is a beautiful object, magnified from 100 to 150 diameters; but a higher power (400 or 500) renders conspicuous a fidgetty motion of angular-looking particles near either extremity of the delicate crescent.

From the great variety of their forms, and the brilliancy of their colours, the Desmids are great favourites with microscopic observers; but their best friends have not contested—as is still done with the Diatoms—the decision which places them in the vegetable world, and ranks them among the confervoid *Algæ*. Like other plants, they evolve oxygen under the influence of light, and for the most part prefer clear water in open situations. Many are found on the surface of mud, others attached to plants, and they have some means of moving towards the light; which is convenient for finding them when they have become buried in the dirt. Although their rank is low, they have an ancient pedigree, and flints abound in fossil remains of the spore-vessels (*Sporangia*) of Desmids, which lived long, long ago, myriads of ages nearer than we are to the dawn of time.

Closterium lunula.

HENRY J. SLACK.

WAYSIDE WEEDS AND THEIR TEACHINGS.

HANDFUL III. CONCLUDED.

In the lesson which we appended to Handful II., we endeavoured to give you some idea of the parts of a perfect flower, their uses and arrangement; we have now to go a step further, and say somewhat of the methods according to which flowers are arranged upon the plants which bear them. Perhaps it never occurred to any of our noviciate readers that flowers are arranged upon their stems in any definite way. They know that their mignonette grows in a little pyramid, their Tom Thumb geraniums and calceolarias in sorts of bunches, and so on, and suppose there is some sort of set fashion for them, but as to what it is, they have not the most remote idea. Let us see whether we cannot make our few wayside weeds give us a clue to unravel, in some degree at least, flower arrangements, or, as it is called in botany,

THE INFLORESCENCE.

We need scarcely remark that flowers, and blossoms generally, are supported upon a stalk or stem of some kind. In certain instances there is but one flower to a stem, as in the primrose, the snowdrop, etc.; in others, the blossoms are crowded on by hundreds and thousands, and in every variety of form and arrangement. Now this primary, or main flower-stem goes by the general name

Fig. 52.—Flower-spikes and Leaves of Common Plantain. The peduncle springing from the root-crown is called a scape. It might also be called a rachis because of running straight to the extremity of the inflorescence.

of *peduncle*, and when, as often occurs, other little stems are given off from it, they are known by the diminutive of *pedicels*, or little stems. When the peduncle springs direct from the root-crown, or root-leaves, and, unbranched, bears a single blossom, it is called a *scape;* but it also bears the name of scape when, as in the daisy, the dandelion, the plantain (Fig. 52), the cowslip, or oxlip, it carries a collection of blossoms. Indeed, the latter plants, although their flowers are differently arranged, approach very near the primrose in their inflorescence,

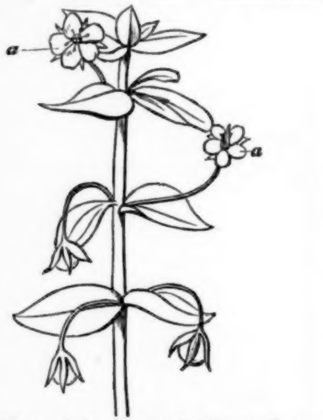


FIG. 53.—Spray of Common Scarlet Pimpernel. *a a*, blossoms, solitary, springing from the axils of the leaves, which are thence called bracts.

and we have only to imagine the primrose scapes bound together part way up, to get the first transition to a compound form of flowering. Again, let us do away with the pedicels of the cowslip blossoms, and mass these together upon the top of the scape, and we get the *head*, or *capitulum*, such as we see in the daisy and other composites, or, reversing the process, prolong the scape, and plant the blossoms closely along it, still keeping away the pedicels, and we have the spike such as we see in the common plantain (Fig. 52), the main stem still retaining the name of scape; in this case it might also be called the *rachis*, another term for a stem, but for one which runs in a straight line from their base through the centre of the inflorescence. Of course, however, the majority of plants, as our readers are well aware, have not the stems thus rising from amid their root-leaves, and the umbel, the spike, or the capitulum, and any other forms of inflorescence may occur in connection with

FIG. 54.—Fine-leaved Heath. Blossoms disposed in a raceme and partly whorled.

other peduncles than scapes; and, on the other hand, solitary blossoms do not necessarily claim scapes for their supports.

Look at Fig. 53, which represents a sprig of the common scarlet pimpernel, a common enough weed, though we have not yet placed it in your hand; the flowers spring all the way up the stem, but each is solitary on its own peduncle, and starts from the junction of the stem with a leaf, or, as it is called, from the axilla of the leaf, the blossoms being described as solitary and axillary. But these leaves, from the axils of which the flowers

spring, might be greatly diminished in size might be dwindled down to little more than, scales, and the peduncles might be shortened; in which case we should have such a form of flower arrangement as we see at Fig. 54, forming what is called a *raceme.* The raceme is one of those most common forms of inflorescence, and may be erect (as in Fig. 54), or drooping, as in the currant (Fig. 55). Now suppose, instead of these little pedicels of the raceme blossoms being all the same length, we have the upper or central ones short, and the lower or outer ones prolonged so as to bring the blossoms nearly to

FIG. 55.—Sprig of Common Currant. Blossoms in a pendent raceme.

the same level, we have a *corymb,* as in the bramble (see Fig. 29, p. 125); but if we take a corymb, and, as it were, draw it out from the centre, we again get the raceme—a change of form of inflorescence which actually occurs in the floral development of such plants as the wallflower and other crucifers, only that in these cases the little scales, or *bracts,* necessary to the true raceme, are wanting. Once more let us have all our pedicels springing from one point, and we have the true umbel (Fig. 30, p. 125), which may be simple, or, as in the figure, compound, the secondary umbels of the compound form being named *umbellules,* or little umbels. As already alluded to, it is only requisite to concentrate the flowers of the umbel to get the head of the composite. When a raceme, still retaining the raceme character, becomes branched, we get the *panicle,* which is the common flowering form of most of the grasses

Fig. 56.—Panicled Inflorescence of Grass.

(Fig. 56), differing, however, greatly in the compactness or diffuseness of its arrangement. Many grasses, such as wheat, barley, darnel-grass, etc., have the true spiked form of flowering, each spike being made up of numerous spikelets (locustæ), and these, as we shall see when we come to

examine grasses, are made up of a larger or smaller number of blossoms. The peduncle of the grass is often called the rachis, and the stem is a *culm*. When a spike of flowers droops, as it does in the poplar, hazel, etc., it is called a *catkin*, and the fertile flower of the hop (Fig. 57) gets the same name. When in our next Handful you make acquaintance

FIG. 57.—Fertile Blossoms of Common Hop. *a a*, scaly flowers arranged in a catkin; when ripe named a strobilus.

with the mint or labiate tribe of plants, to which the common red or dead nettle (Fig. 58) belongs, you will find a still different flowering plan; for the blossoms are collected closely round the stem, in the leaf axils, in little bundles properly called verticillasters, but often described as whorls. The stinging nettle (Fig. 59), not the slightest connection, not even a "Scotch cousin," of its namesake, has its flowers—some of our readers stare at the idea—in little clusters, each one of which constitutes a *glomerulus*. One of the most unique forms of inflorescence, however, is the *spathe* (Fig. 60), which is composed of an assemblage of blossoms inclosed within a sort of sheath or hood; as in the wake-robin—lords and ladies—so common by English hedge-sides in early spring, and most English children know it, and will readily recognize what is meant. Almost we fear to bewilder you with these varied names and descriptions, which it is difficult to make attractive to a beginner, though it is well to get some knowledge of

them. Only one more, and we have done. Look at Fig. 48, which illustrates the fruit-cluster of the common elder; it is neither umbel, corymb, nor raceme, but seems a mixture of all three, and gets the name of *cyme*. It is most near the corymb, however, in form, and derives its principal diversity from the order in which its blossoms become developed and expanded; albeit this brings us to another subject connected with inflorescence—the order of expansion of blossoms, whether definite or indefinite, whether tending towards the centre of the floral axis or centre, or tending away from it. It is, perhaps, better, in these our early days of weed-gathering, not to puzzle you with this subject; it is scarcely requisite for our first lessons, which we are bound in good faith to keep as simple for you as possible. Look back to Fig. 53, the sprig of scarlet pimpernel: the solitary flowers spring from the axils of what we called leaves, but leaves they are not in the eye of a botanist, for their proper designation is

FIG. 58.—Red Dead Nettle; the blossoms disposed in whorls or verticillasters.

FIG. 59.—Common Stinging Nettle. Inflorescence in a glomerulus.

BRACTS.

In many instances, as in the one in question, the bracts are scarcely, if at all, distinguishable from the ordinary leaves of the plant. This is more especially the case with the lower bracts of

a flower series, for the upper ones become less leaf-like; nevertheless, whether in every respect like an ordinary leaf, or whether not more than an insignificant scale, the appendage at the base of a peduncle or pedicel is always known as the bract. Refer back to the various figures with which the present paper and those preceding are illustrated, and you will find numerous instances of bracts. At times, however, bracts, or collections of bracts, are called *involucres*, when they envelope such collections of blossoms as the heads of the composites, the umbels, etc. The bract of the common lime-tree is such an excellent example of bract formation (Fig. 61), that though the lime is scarcely a "way-side weed," we make no excuse for bringing it forward. If you really do not as yet know a lime-tree, you cannot miss it henceforth when you know that you cannot go within many yards of it in July without being attracted by the scent of the blossoms, or by the hum of the myriads of bees which swarm around it. Go, pray, for the sake of the bract, pluck a twig of the first lime you meet with, only remember it belongs to Handful No. I., for it is a many-petaled bloomer.

SPENCER THOMSON, M.D.

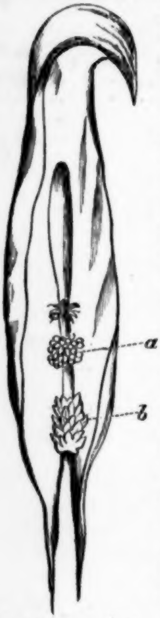


FIG. 60. Reproductive Organs, or Flower of Common "Wake-robin," inclosed in a large bract, called a spathe. *a*, stamens; *b*, pistils.

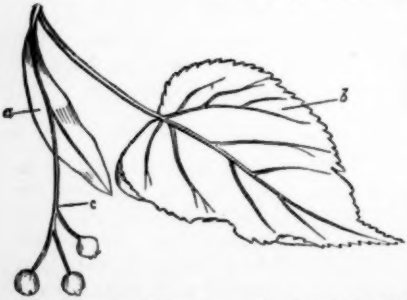


FIG. 61.—Twig of Lime-tree. *a*, bract; *b*, leaf; *c*, fruit

BRUTE MADNESS.

AMONG the singular occurrences met with in the animal world, I never heard of a more curious one than that which I am about to relate:—A lady, resident in the country, was fond of rearing poultry; among these was a young pullet, which successfully brought out a brood of some ten or twelve chickens. All went on well for a time; but the adjoining farm-yard was infested with rats, and in one fatal night the whole brood was carried off—clean gone, and not a vestige remained to tell the tale. The poor mother was first disconsolate, and then became positively frantic, and did all that a dumb creature could do to show that her brain was completely turned.

Time, which assuages all woes, seemed at last to mellow her delirium of grief into a settled misalectrophy, or advised hatred of chanticleer and all his race; and never from that moment did she produce a single egg, or bring up another brood. Her comb became enlarged, spurs sprouted on her legs; her tail feathers grew long and drooped, and her morning crow rivalled that of the greatest patriarch of the yard! Strange metamorphosis, and all arising from the shock to her maternal love; that powerful, all-engrossing feeling—that στόργη (*storgē*), as the Greeks appropriately called it—which, in this instance, not only endowed one of the gentler sex with the intrepidity of the bolder, but positively invested her with their outward attributes.

O. S. ROUND.

A CATALOGUE OF ALL THE COMETS WHOSE ORBITS HAVE HITHERTO BEEN COMPUTED.

(Concluded from page 285.)

(Concluded from page 285.)

No.	Year.	PP.	π.	☊.	ι.	q.	ε.	μ.	Calculator.	Date of Discovery.	Discoverer.	Duration of Visibility.
		d. h.	° ′	° ′	° ′							
(87)	1852iii.	Sept. 28, 16	109 8	245 52	12 33	0·8606	0·75625	+	Santini	1852, Aug. 25	Secchi	5 weeks.[1]
193	— iv.	Oct. 12, 15	43 12	346 13	40 58	1·2510	0·92475	+	Marth	— June 27	Westphal	24 weeks.[2]
194	1853 i.	Feb. 24, 6	153 21	69 49	20 19	1·0938	...	—	Von Littrow	1853, Mar. 6	Secchi	3 weeks.[3]
195	— ii.	May 10, 8	201 12	41 12	57 53	0·9044	...	—	Bruhns	— April 4	Schweitzer	10 weeks.[4]
196	— iii.	Sept. 1, 17	310 58	140 31	61 30	0·3067	...	+	D'Arrest	— June 10	Klinkerfess	4 months.[5]
197	— iv.	Oct. 16, 14	301 7	220 4	61 1	0·1725	...	—	Hoffmann	— Sept. 11	Bruhns	11 weeks.[6]
198	1854 i.	Jan. 9, 6	55 57	227 3	66 7	1·2002	...	—	Marth	— Nov. 25	Van Arsdale	12 weeks.[7]
199	— ii.	Mar. 24, 0	213 47	315 26	82 22	0·2770	...	—	Hornstein	1854, Mar. 23	Many observers	4 weeks.[8]
(12)	— iii.	June 22, 2	272 58	347 48	71 8	0·6475	...	—	Klinkerfess	— June 4	Klinkerfess	10 weeks.[9]
200	— iv.	Oct. 27, 9	94 20	324 34	40 59	0·8001	...	+	C. Bruhns	— Sept. 11	Ditto	11 weeks.[10]
201	— v.	Dec. 16, 1	165 52	238 19	14 10	1·3673	...	+	Winnecke	— Dec. 24	Colla	16 weeks.[11]
202	1855 i.	Feb. 5, 17	226 33	189 40	51 12	1·2195	...	—	Ditto	1855, April 11	Schweitzer	5 weeks.
(21)	— ii.	May 30, 5	237 36	260 15	23 7	0·5678	0·99090	—	Donati	— June 3	Donati	2 weeks.[12]
(100)	— iii.	July 1, 5	157 53	334 26	13 8	...	...	+	Encke	— July 13	Maclear	5 weeks.[13]
203	— iv.	Nov. 25, 15	85 21	52 2	10 16	1·2248	...	—	G. Rümker	— Nov. 12	Bruhns	7 weeks.[14]
204	1857 i.	March 21, 8	74 49	313 12	87 57	0·7721	...	+	Pape	1857, Feb. 22	D'Arrest	9 weeks.[15]
(170)	— ii.	March 29, 5	115 48	101 53	29 45	0·6202	0·80160	+	Bruhns	— Mar. 18	Bruhns	11 weeks.[16]
205	— iii.	July 17, 23	249 37	23 40	58 59	0·3675	...	—	Pape	— June 22	Klinkerfess	3 weeks.
206	— iv.	Aug. 24, 8	23 24	200 19	31 38	0·7427	...	+	Villarceau	— July 25	Peters	5 weeks.[17]
207	— v.	Sept. 30, 19	250 21	14 46	56 18	0·5651	...	—	Bruhns	— Aug. 20	Klinkerfess	7 weeks.[18]
208	— vi.	Nov. 19, 1	44 15	139 18	37 50	1·1009	...	—	Pape	— Nov. 10	Donati	5 weeks.[19]
(189)	— vii.	Nov. 28, 1	322 55	148 27	13 56	...	0·66014	+	Lind	— Dec. 10	Maclear	5 weeks.[20]
(106)	1858 i.	Jan. 22, 0	115 29	268 54	5[illegible] 32	1·0274	0·82961	+	Bruhns	1858, Jan. 4	H. P. Tuttle	9 weeks.[21]
(135)	— ii.	May 2, 11	275 38	113 32	10 48	0·7689	0·75466	+	Winnecke	— Mar. 8	Winnecke	12 weeks.[22]
209	— iii.	May 2, 1	195 42	171 3	23 11	1·2090	...	+	Hall	— May 2	Tuttle	4 weeks.
210	— iv.	June 5, 4	226 6	324 21	80 28	0·5462	...	—	Bruhns	— May 21	Bruhns	3 weeks.[23]
(165)	— v.	Sept. 12, 14	49 49	209 45	11 21	1·6999	0·55502	+	Ditto	— Sept. 8	Ditto	8 weeks.[24]
211	— vi.	Sept. 29, 23	36 13	165 19	63 1	0·4822	0·99647	—	Ditto	— June 2	Donati	7½ months.[25]
212	— vii.	Oct. 12, 19	4 13	159 45	21 16	1·4270	...	—	Weiss	— Sept. 5	H. P. Tuttle	8 weeks.
(100)	— viii.	Oct. 18, 11	157 57	334 28	13 4	0·3407	0·84639	+	Powalki	— Aug. 7	Förster	10 weeks.[26]
(87)	1859 i.	May 24 0	109 33	245 43	12 23	0·8680	0·75349	+	Hubbard	...	...	...[27]
213	— ii.	May 29, 5	75 9	357 7	84 9	0·2020	...	—	Hall	1859, April 2	Tempel	12 weeks.

1 An apparition of *Biela's comet*. Theoretical elements.

2 Discovered also by Peters. Visible to the naked eye early in October. Period, 70 years.

3 Discovered by Schweitzer and C. W. Tuttle, March 8, and by Hartwig, March 10. Elements resemble those of the comet of 1664.

4 Visible to the naked eye in the beginning of May, with a tail 3° long.

5 Visible in the daytime, August 31 to September 4. In the south of Europe, a tail 15° long was seen.

6 Perceptible to the naked eye about the middle of the month. Elements resemble those of the comet of 1582.

7 Discovered by Klinkerfess, December 2.

8 First seen in the south of France, when very conspicuous, with a tail 4° long. Elements resemble those of the comet of 1799 (ii).

9 Discovered also by Van Arsdale. At the time of the PP. it was visible to the naked eye. The elements strongly resemble those of the comets of 961 and 1558.

10 Discovered also by several other observers.

11 Discovered by Winnecke and Dien, January 15, 1855.

12 Discovered also by Dien and Klinkerfess. Probably a return of the comet of 1362. Period assigned, 493 years.

13 An apparition of *Encke's comet.*

14 Discovered also by Van Arsdale.

15 Discovered also by Van Arsdale. Orbit decidedly parabolic.

16 An apparition of *Brorsen's comet*, (1846 ii).

17 Discovered by Dien, July 28, and by Habicht, July 30. Believed to revolve in an elliptic orbit, to which a period of 258 years has been assigned.

18 Faintly perceptible to the naked eye, September 20. It had a short tail. Elements resemble those of the comets of 1790 (iii) and 1825 (i). An elliptic orbit, to which a period of 1618 years, has been assigned by Villarceau.

19 Discovered a few hours later by Van Arsdale.

20 An apparition of *D'Arrest's comet*. Period, 2331 days. Element "q" not *published*.

21 Discovered by Bruhns, January 11. Probably a return of the comet of 1790 (ii). Period assigned, 13·6 years.

22 An apparition of *Pons' comet* of 1819 (iii). Period, 5·549 years.

23 Elements resemble those of the comet of 1799 (ii).

24 An apparition of *Faye's comet.*

25 One of the finest comets of the present century. It became visible to the naked eye early in September, and was very conspicuously seen in Europe for about six weeks, when, owing to its rapid passage to the southern hemisphere, it became lost to view. It was seen at Santiago till March 1, 1859. During the first week in October it had a tail nearly 40° long. An elliptic orbit; period assigned, 2101 years.

26 An apparition of *Encke's comet.* It was very faint.

27 Theoretical elements of *Biela's comet.* It was unfavourably placed for observation, and escaped detection.

Eastbourne. GEO. F. CHAMBERS.

METEOROLOGY OF APRIL.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Amount of Rain. Inches.	Range of Temperature.
1843	66·5	26·0	2·5	40·5
1844	73·5	36·0	0·9	37·5
1845	70·1	33·5	1·3	36·6
1846	63·5	33·0	4·3	30·5
1847	62·5	28·0	1·3	34·5
1848	75·5	27·0	2·2	48·5
1849	67·5	24·3	2·0	43·2
1850	64·6	29·8	2·2	34·8
1851	70·5	27·5	1·5	43·0
1852	75·5	27·8	0·5	47·7
1853	68·2	28·6	1·8	39·6
1854	74·8	29·4	0·5	45·4
1855	67·8	22·6	1·0	45·2
1856	70·0	28·5	2·4	41·5
1857	69·0	28·2	3·1	40·8
1858	79·0	23·0	2·3	56·0
1859	78·0	21·8	2·4	56·2

The greatest heat in shade reached 79·0° in 1858, and only 62·5° in 1847, giving a range of 16·5° in greatest heat for April during the past seventeen years. In 1859 the temperature rose to 78°, the next hottest years being 1852, 1848, 1854, and 1844; and the coldest 1847, 1846, and 1850.

The greatest cold was as low as 21·8° in 1859, and never below 36·0° in 1844, giving a range of 14·2° for greatest cold in April for the past seventeen years. The temperature was very low also in 1858, 1855, and 1849, the warmest years being 1844, 1845, and 1846.

The range of temperature in April was as much as 56·2° in 1859, and 56·0° in 1858, whilst it was only 30·5° in 1846.

Only half an inch of rain fell in 1852 and 1854, and as much as 4·3 inches in 1846, giving a range of 3·8 inches for April during the past seventeen years. In fourteen years the fall exceeded an inch, and in nine years it exceeded two inches; the mean amount of rain for April being 1·9 inches.

April is a changeable month. E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR APRIL, 1860.

The sun is in the constellation of Aries until the 19th, after which he is in Taurus. He rises on the 1st in London at 5h. 37m., on the 10th at 5h. 17m., on the 20th at 4h. 55m., and on the 30th at 4h. 35m., being an hour and two minutes earlier on the last day than on the first. He sets in London on the 1st at 6h. 32m., on the 10th at 6h. 47m., on the 20th at 7h. 3m., and on the 30th at 7h. 20m., or 52 minutes later than on the 1st. At Dublin, at the beginning of the month, he rises three minutes earlier and at the end eight minutes earlier than in London, and sets at the beginning two minutes later and at the end eight minutes later than in London. In the middle of the month he rises at Edinburgh ten minutes earlier and sets eleven minutes later than in London.

The sun reaches the meridian on the 1st at 12h. 3m. 50s.; on the 10th at 12h. 1m. 13s.; on the 14th at 12h. 0m. 10s., and on the 30th at 11h. 57m. 2s.

The equation of time on the 1st is 3m. 50s.; on the 10th, 1m. 13s.; and on the 14th, only 10s.; the clock being these amounts before the sun, *i. e.*, the equation of time addative. On the 30th it is 2m. 58s. after the sun, and therefore subtractive.

Day breaks on the 2d at 3h. 34m., and on the 27th at 2h. 17m.

Twilight ends on the 14th at 9h. 4m.

Length of day on the 3rd, 13h. 3m., and on the 21st, 14h. 12m.

Duration of twilight after sunset on the 1st, 2h. 0m., and on the 21st, 2h. 16m.

The moon is full on the 5th at 10h. 0m. p.m.

New moon on the 21st, at 5h. 45m. a.m.

The moon is nearest to the earth on the 4th, and furthest removed from us on the 19th.

Mercury becomes a morning star on the 3rd. He is in Pisces throughout the month, becomes stationary on the 15th, and reaches his greatest westerly elongation on the 30th, when he is favourably situated for observation. He rises on the 10th at 4h. 50m. a.m.; on the 20th at 4h. 24m.; and on the 30th, at 4h. 4m. a.m.; setting on the 1st at 6h. 52m. p.m., and on the 26th at 4h. 35m. At the end of the month he will present the form of a slender crescent of 11s. or 12s. in diameter.

Venus is an evening star, and still increasing in brilliancy. She is in Taurus, and well situated for observation, and will become brighter every night throughout the month. She is on the meridian on the 10th at 2h. 51m. p.m., and on the 30th at 3h. 5m. p.m., setting on the 1st at 11h. 7m.; on the 20th at 11h. 30m., and on the 30th at 11h. 46m.

Mars is badly situated for observation, yet increasing in brightness; he is in the constellation of Sagittarius. He is very low, rising only a few degrees above the horizon, even when on the meridian. He rises on the 10th at 1h. 36m. a.m., and on the 30th at 12h. 56m. a.m., reaching the meridian on the 10th at 5h. 27m. a.m., and on the 30th at 4h. 48m. a.m.

Jupiter is an evening star, and although conspicuous is decreasing in brilliancy. He is in Gemini throughout the month. He rises on the 10th at 10h. 16m. a.m., and on the 26th at 8h. 51m. a.m.; reaches the meridian on the 10th at 5h. 56m. p.m., and on the 30th at 4h. 47m. p.m., setting on the 1st at 2h. 45m. a.m., and on the 30th at 1h. 0m. a.m.

Saturn is a conspicuous object in the constellation of Leo. He rises on the 1st at 1h. 18m. a.m., and on the 26th at 11h. 38m. a.m.; reaches the meridian on the 10th at 8h. 12m. p.m., and on the 30th at 6h. 53m. p.m., and sets on the 10th at 3h. 45m. a.m., and on the 30th at 2h. 26m. a.m.

Uranus is in Taurus, and, setting very early, is unfavourably situated for observation.

The Intra-Mercurial Planet is expected to transit the sun as a black spot some time between March 25th and April 10th.

Occultations of Stars by the Moon at Greenwich :—There is only one of any size, viz., on the 8th, when π Scorpii (3rd magnitude) disappears at 10h. 32m. p.m., and reappears again at 11h. 34m. p.m.

Eclipses of Jupiter's satellites at Greenwich :—On the 1st, at 8h. 49m. 45s. p.m., 3rd moon disappears. On the 1st, at 9h. 44m. 54s. p.m., 1st moon reappears. On the 2nd, at 12h. 13m. 8s. a.m., 3rd moon reappears. On the 8th, at 11h. 40m. 22s. p.m., 1st moon reappears. On the 9th, at 12h. 49m. 47s. a.m., 3rd moon disappears. On the 17th, at 8h. 4m. 41s. p.m., 1st moon reappears. On the 23rd, at 8h. 52m. 10s. p.m., 2nd moon reappears. On the 24th, at 10h. 0m. 11s. p.m., 1st moon reappears. On the 30th, at 11h. 27m. 26s. p.m., 2nd moon reappears. On the 16th and 23rd, at 9h. 30m. p.m., 1st moon will be on the disc of Jupiter, and on the 21st at the same hour the 2nd moon.

E. J. Lowe.

THINGS OF THE SEASON—APRIL.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

—o—

Birds Arriving.—Quail, Ring Dottrel, Turtle Dove, Nightingale, Blackcap, Cuckoo, White-throat, Grasshopper Lark, Pettychaps, Wood Wren, Swift, Swallow, Sand Martin, House Martin, Puffin, Yellow Wagtail, Water Rail, Pied Flycatcher, Whinchat, Common and Less Tern, Sandwich Tern, Wryneck, Ring Ousel, Ruff, Lapwing, Redshank, Redstart, Sandpiper. The majority of the arrivals take place between the 10th and 20th.

Birds Departing.—Green and Purple Sandpiper, Gray and Herring Gull, Crossbill, Shoveller, Short-eared Owl, Cambridge Godwit.

Insects.—Abax striola, Attagenus pellio, Clivina fossor, Carabus hortensis, Platynus angusticollis, Elaphrus riparius, Helophorus aquaticus, Silpha obscura, Onthophagus species, Chrysomela sanguineolenta, Melandrya caraboides, Staphylinus ænocephalus, Opatrum sabalosum, Typhæus vulgaris, Mole Cricket, Bloody-nosed Beetle, Early White, Howard's White, Small White, Speckled Wood White, Common Copper, Hebrew Character, Emperor, Silver Y, Six-cleft Plume, Angleshades.

Wild Plants in Flower.—Vernal Speedwell, Cotton Grass, Yellow and Blue Scorpion Grass, Cyclamen, Oxlip, Cowslip, Dog, Hairy, and Marsh Violet, Spring Gentian, Fritillary, Wild Tulip, Star of Bethlehem, Vernal Squill, Golden, Purple, and White Saxifrage, Wood Sorrel, Vernal Cinquefoil, Wood Anemone, White Dead-Nettle, White Cardamine, Hedge Rocket, Wallflower, Fumitory, Dandelion, Bitter Bur, Purple and Spider Orchis, Great Carex, Ash, Oak, Beech, Birch, Willow. In wet places Equisetum sylvaticum cum aliis, and in brooks Chara flexilis.

Mr. Noteworthy's Corner.

The Rifleman's Eye.—Mr. Noteworthy's young people are ankle-deep, knee-deep, neck-deep, in the perusal of that elegant and attractive work, "Many Happy Returns of the Day," by Mr. and Mrs. Cowden Clarke; and Mr. Noteworthy himself, with all his stolidity, can hardly help taking a deep dip now and then. As for the juveniles, they begin to think that human life ought to be a series of birthdays, in order that books full of anecdotes and pictures might come home diurnally. In reading the chapter on outdoor sports, and believing himself to be a boy again, Mr. Noteworthy lighted on a narration of the experiments of Colonel Hamilton Smith, which he here cites as a lesson in the study of colour. Three targets were chosen—Red, Green, and Gray. Ten of the best shots fired at them, two shots a-piece first, in this order, Red, Green, Gray, then Green, Gray, Red, and lastly, Gray, Red, Green. The result was, that the red target was shot to splinters before the complement of sixty balls had been shot at it; the green was severely treated, but not destroyed, and the gray was comparatively uninjured. Thus a gray coat is as good as shot proof armour to a soldier in the field, a green one dangerous, and a red an open exposure to death. Our Volunteer Rifles may take a lesson from these experiments, as may also the student of the laws of colour.

Coating for Plaster-casts.—Years ago Mr. Noteworthy used to amuse himself by converting plaster-casts into imitations of wax and marble by means of white wax and immersions in oil. Though he so prepared a whole set of the Poniatowski gems, he has clean forgotten the whole process, and is unable to satisfy the inquiries of some of his friends, who desire to become proficient in such manipulations. Will some of the readers of Recreative Science, who are adepts at this kind of work, send brief practical receipts for this Corner, that we may all know how to give the gloss of marble and the bloom of alabaster to the cheap works of art that are to be found in cottage skylights and the mantle-shelves of tasteful people?

Solvent for Dry Paint.—"Dingler's Polytechnic Journal" contains a useful recipe by M. C. Brunner, who states that, having been often applied to by artists for a means of removing *dried* oil-colours from paint-brushes and other substances, he made a series of experiments, which conducted him to the following method:—A solution of one part of *crystallized* carbonate of soda in three parts of water is prepared; the brushes to be cleaned are suspended in this fluid, so that they may remain at about two inches from the bottom of the vessel in which they are placed. The apparatus is now submitted to a gentle heat from twelve to twenty-four hours, according as is found necessary. The heat should not exceed 160° Fahrenheit, as this is sufficient to soften the colour, and render it re-

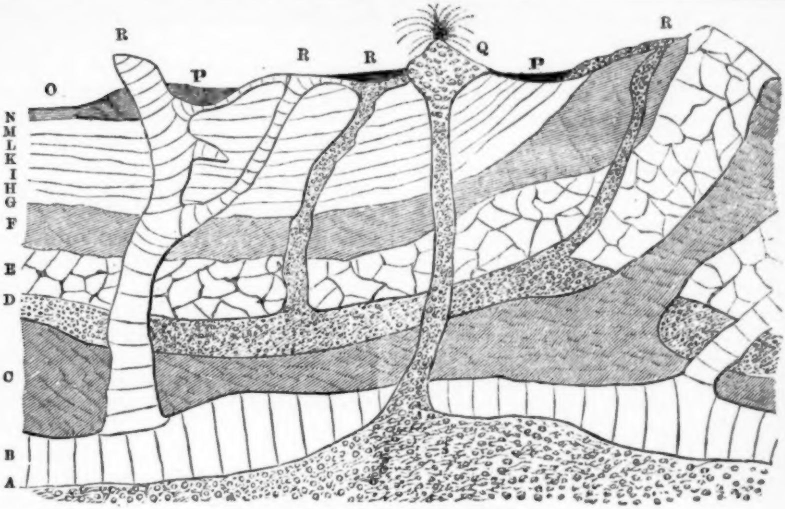
movable in the ordinary way with soap and water; a greater heat would spoil the hairs, especially of hog-tools.

Restoration of Fractured Bells.—Since the two renowned failures in connection with the great bell of the Westminster Palace, scientific men have been engaged in numerous experiments and inquiries, with a view to reduce to certainty the at present uncertain details of the composition and mechanism of bells. In one instance a result has been arrived at, which renders it probable that a cracked bell, however large, may be restored to perfect working order. At a recent meeting of the Institution of Civil Engineers, Mr. Varley exhibited a cracked bell, which had been recovered by soldering the crack with tin, so that it was as sonorous as before. The principle of the restoration is this :—Tin when heated above the boiling point to nearly a red heat, dissolves copper, and combines with it to form an alloy. The bell, being first soldered with tin, must be kept at a red heat for a certain length of time, during which the copper in the bell-metal, in the parts adjoining the crack, mingles with the tin with which the crack was soldered, and thus the soldering becomes homogeneously combined with the mass, as if a part of its original structure; and the bell resumes the utterance of its original tones.

Propagation by Candle-heat.—Among the curiosities of horticulture, is the newly-introduced method of propagating plants by the heat of a candle-flame, which is the result of experiments by one of Mr. Noteworthy's friends. The useful invention known as the Waltonian case was formerly heated with an oil lamp or gas-jet, and the object of obtaining a candle suited to it was to render it available as a recreation for the sick-room, where the invalid could watch the growth of the plants, and by the definite number of hours which the candles burn, entrust the management of the heating apparatus to a domestic wholly unskilled in the operation. Just as the candle or mortar heats the boiler on which the plants are placed, so it would prove a cleanly and certain source of heat for many chemical operations, and for the sick-chamber, and even for the dinner-table, to keep the venison hot. The next step in this direction should be to adapt an efficient heating apparatus to Wardian cases, to enable amateurs to preserve, during the winter, many of the choice silver and gold ferns, and other exotic Filices, that too commonly perish through having to endure too low a temperature in dwelling-rooms and entrance-halls. In the March Number of the *Floral World* will be found a description, with figures, of the Waltonian case as adapted to be heated with the candles.

Rockwork for Aquaria.—Several correspondents, who have inquired of Mr. Noteworthy on this subject, are informed that the *best* of all materials for rockwork in aquaria is mica schist, because on that kind of rock the confervoid vegetation appears the soonest, and endures longest, so as to provide an abundant supply of oxygen to the animal inhabitants. Coke washed with Portland cement and pumicestone is often used, because it is lighter than other materials, and the tanks made on the old plan are unable to bear the pressure of a large mass of rock, and without rock where is the nidus for spontaneous vegetation? Whenever cement can be dispensed with the better, and it is not a difficult matter to build up rockwork wholly without it. The best cement is Portland, which does not crumble if mixed in small quantities at a time, and used quickly. As the tanks are now made with Mr. Lloyd's joints and elastic cement (patented, and kept secret), they are capable of bearing without strain as much rockwork of any kind as can be got into them. Mr. Noteworthy has recently inspected Mr. Lloyd's new arrangements at Portland Road, Regent's Park, and rejoices to be able to bear testimony to the assiduity, enterprise, and scientific skill of that eminent purveyor of stock to the whole aquarian world.

The Great Tide of the 8th.—To enter fully into the subject of tidal phenomena would be out of place here; but as several of Mr. Noteworthy's friends ask for a reason in reference to the great tide of the 8th, a few words will suffice to explain it. The attraction of the moon heaps up the waters of the earth, and if the earth and moon were stationary, the waters would assume the form of an oblong ellipsoid; but as neither are so, there is never time for the spheroid to be formed. The effect of the motion of the attracting power is to cause a vast flat wave, which follows the apparent motions of the moon; when the higher or lower parts of this wave strike our coasts, we say it is high or low water. The sun exercises also a great attractive force, and sometimes the wave formed by the sun is added to that formed by the moon, when sun and moon act together in the same direction; and at other times the sun-wave is formed transversely to that of the moon, and the lunar-wave is thus weakened; hence we have spring and neap tides. On the 7th of March last the moon was at the full, hence sun and moon were on opposite sides of the earth, and a spring-tide would be the consequence, the waters being equally heaped up on the two hemispheres. But the moon was also in perigee—that is, at a point of her orbit *nearest* the earth, and the sun being at the same time at the equator, on his way to inaugurate the northern summer, the two bodies acted together with more than usual force, and so equally as to neutralize each others action the least possible. Thus a well balanced and augmented attraction on opposite sides of the earth caused the tide-wave to rise higher than ordinary; and, as a consequence, there was a considerable amount of excitement at seaports, and on the banks of navigable rivers, at the deviation of the waters from their customary levels. As the great tide was predicted by astronomers, much property was saved from destruction by the precautions taken in anticipation of the event. In September next, when the sun will be again on the line to act in conjunction with the moon, the great September tide will afford a good opportunity to visitors to the coast to study the subject, as well as to make good gatherings of marine objects for the aquarium.



THEORETICAL SECTION OF THE EARTH'S CRUST.

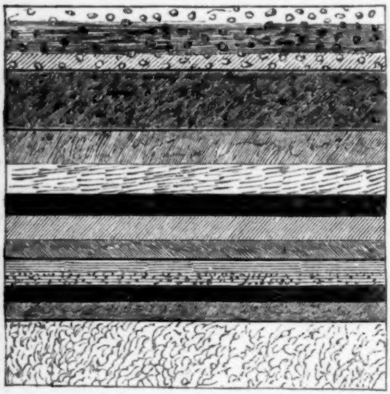
A, Ancient and modern lavas; B, Basalt; C, Porphyry; D, Greenstone; E, Granite; F, Crystalline schist; G, Silurian; H, Carboniferous; I, Limestone; K, Red sandstone; L, Lias; M, Chalk; N, Tertiary; O, Drift; P, Alluvium; Q, Volcano, communicating with the lowermost Plutonic strata; R, Traps and dykes.

PHYSICAL EVIDENCES OF THE INTERNAL HEAT OF THE EARTH.

PART II.—GEOLOGICAL AND PLANETARY STRUCTURE OF THE EARTH.

HE success which has attended the investigations of Sir Charles Lyell, and the geologists generally of the modern school, arises out of the method of reasoning adopted in tracing effects to proximate causes. By what we observe in the changes now taking place on the surface of the earth, we infer the nature of the changes which formed the successional phenomena of ages long since past, when, truthfully speaking, they were *not* phenomena, because there was no human eye to behold them. The great Humboldt built up his "Cosmos" on data collected from the present aspects of Nature, and by the same data we must reason respecting the nature of those fiery forces which have so powerfully operated in giving the habitable globe its present external form and character. That heat was the agent under which the materials of the earth's crust were first modified, is the leading lesson of Geology. If we make a section of the earth's crust, the *order* of superposition is *always* the same. From the modern alluvium we proceed downwards to the tertiary, thence to the chalk, the oolite, the new red, the carboniferous, the old red, the silurian, and at last come upon the sedimentary rocks which have been crystallized by heat. Beneath these are the foundation beds of granite, in which there are no traces of the action of water, but abundant evidences that they have passed into the solid form, after having been molten for ages. We may find traps, and dykes, and metalliferous

veins, but these traps and dykes can be traced downwards to the igneous series, and be proved to have been ejected through and over the sedimentary matter they have disturbed, after that sedimentary matter had been accumulated in the beds of seas and lakes, and hardened into rock. Familiar as this fact is to every student of geology, indeed, without a recognition of the chronological order of the strata of the earth's crust, there is no science in Geology at all, yet it needs here to be enforced as the leading link in the chain of evidence by which the theory of the internal heat of the earth is to



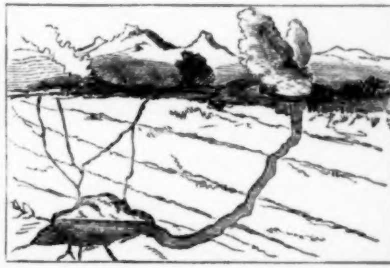
Order of Strata, forming the lower portion of the earth's crust.—1, Plutonic rocks; 2, gneiss; 3, mica-schist; 4, clay-slate; 5, silurian; 6, old red sandstone.

be established. It matters not under what form the igneous rocks present themselves, whether as granite, porphyry, basalt, chlorite, or serpentine, they all agree in their general characteristics as the crystalline products of simple fusion, and when we arrive in our upward course upon the gneiss and mica-schist, we find stratification by the agency of water, and crystallization through the deposit having been made upon the heated granite bed. Thus the lowest of the series of rocks forming the earth's crust, as far as we are acquainted with them, were originally in a state of fluidity by heat, and, in cooling, the constituent materials assumed either the crystalline confusion observable in granite, or the columnar form seen in basalt, and sometimes in porphyry. These lowest beds also rise to the highest altitudes upon the earth's surface; the granite of the Alps only dips under the tertiary of Vienna, to rise again on the western end of the Carpathians, the eastern half of which consists of secondary, greatly modified by the heat of the granite, on the shoulders of which it was originally heaved to the surface. The peaks of the Caucasus, the Grampians, the hills of Auvergne, the Pyrenees, the north of Wales, and the south of Ireland, and the belt of country from the Ural chain to the western coast of Scandinavia, claim kindred as to their origin with the tuff and pumice of Sicily and Naples, Auvergne and Dresden. Unless the heat had been sufficient to upheave and break through the first-formed crust of igneous matter, and to have continued even till now to disturb the uppermost layers of water-formed rock, the earth must have remained a sightless and unfruitful level plain—a plain submerged, perhaps, under a thin, continuous film of water. But the struggle of the heat for escape has caused the protrusion of traps that have scorched the rocks through which they passed on their way to the cool surface. It has converted beds of coal into anthracite, brought within man's reach veins of useful metals, beds of useful coal, and, in many places, exposed to view for his instruction the order of superposition, and the relative places in time of the several sedimentary formations. To the earthquake and the volcanic throe he is indebted for the sparkling stream that is fed for ever from the mountain snows, indebted for the rounded hills that feed his flocks, and the table-lands that wave with corn, and for the fertile valleys wherein the soaring bird and the soaring heart sing together to the praise of God. If we leave Europe, and

make the tour of the world, everywhere we meet with igneous rocks upon the summits of the hills, and on the seaboard of the Pacific active craters accompany the line of the upheaval to awful altitudes of the rocks which occupy the lowest place in the geological series.

Let us at this point go back to remote geological antiquity, and picture the earth a rocky and sterile mass, but just cooled sufficiently to permit the existence on its surface of water in a liquid form. The soil is yet too hot for life in any of its forms; many of the more volatile elements are still floating in the atmosphere, still uncondensed and unabsorbed. The seas boil furiously, and the huge bubbles of ebullition keep up a roaring din, which mingles with the blasts of Vulcanian forges, and the thunderous rumblings of earthquakes on the land. Immense volumes of steam involve the world in terrible darkness, and showers of hot water fall upon the hotter soil. As the rains fall, the rocks splinter and sever into zigzag seams, and the water flowing through, reaches the terribly heated mass below. Steam is generated in enormous quantity, every particle of water expanding into 1700 times its former bulk; or the water itself is decomposed into its component gases, which occupy many thousand times the space of the water from which they are formed, and these, suddenly produced in confinement and under pressure, will fight fiercely for escape. Then will commence the sharp struggle of gas and vapour fighting for freedom, and in the hour of this terrible convulsion, the rocky crust will be torn and shattered, the fiery tide will be protruded, and the masses ejected will form the granite peaks which now crown the world, and pierce the heavens with their grand pinnacles of snow.

In thermal springs we find a still further confirmation of the theory. Boiling springs, like earthquakes, are most frequent near volcanoes. The Geysers of Iceland are in close proximity to Mount Hecla, and doubtless derive their heat from the rocky reservoirs out of which they flow, the immediate source of the fountain being a portion of the volcanic soil which has an immediate connection with



Theoretic Section of a Geyser, showing the cavity in which the water collects by percolation, and from whence by the pressure of confined steam it is forced along the pipe at the time of eruption.

the internal fires. The celebrated springs of Soltaferra—the steam of which is used to drive the mills in the adjacent factories—have more than a chance connection with Vesuvius; and, indeed, by some geologists, and particularly by Professors Phillips and Daubeny, boiling springs are regarded but as a class of volcanoes, in which the product of eruption is water in a comparatively pure form.

Pallassou first explained that the temperature of springs decreases in proportion to their distance from the great granite mass, and that springs having their source in layers of sedimentary formation much above the granite, vary in temperature with the seasons and the weather, while the deep-seated springs have a constant heat, which is unaffected by external circumstances. So definitely is this the case, that it is regarded as a law of the Artesian and other wells, that the deeper the source the warmer is the water that flows from it, and this, too, in an ascertainable ratio. It is also worthy of remark that thermal springs, though frequent in volcanic districts, are by no means confined

to such, but are found in all kinds of situations and of very high temperatures in sites remote from volcanic influence. Nor do we find, as we could not fail to do if they existed, any traces in these thermal waters of chemical ingredients, such as would in themselves give rise to heat, nor, indeed, of any that might result from decompositions which had already given rise to an elevation of temperature. Witness the waters of Naters, North Wales, which rise at a temperature of 58° Fahrenheit; those at Leuck at 72°; of Bagnes at Lavey, near Bex, at 65°; Sante de Pucelle, at Chamouni, and St. Gervaise, on Mont Blanc, both registering 52° or 53°; Cormayeur and St. Didier, on the southern declivity of Mont Blanc, at 50°; and those at Aix-les-Bains, in Savoy, at 70° to 72°. All these springs are noted for the comparative purity of their waters, and the steadiness of their temperature, without regard to the vicissitudes of the seasons, and in each case the relative temperature is in proportion to the distance of the fountain from the basal granite.

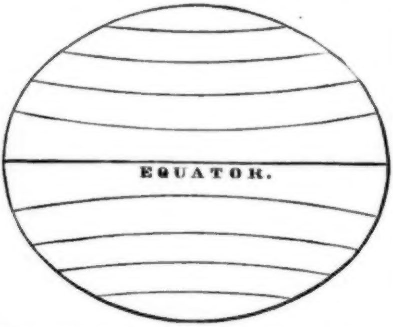
At Carlsbad the springs have a temperature of 165° Fahrenheit, or nearly double the warmth of the human body, and none of the ingredients which the water yields, on analysis, account in any way for its heat. At Aix-la-Chapelle, the waters rise at 143°; at Bath, at 114°; and in both instances the sources of the supply are near, or upon, primitive beds of granite. Most mineral waters contain lime, common salt, potash, minute proportions of sulphates and phosphates, and large quantities of carbonic acid; and of these the lime is the only one which could give rise to heat. But any one acquainted with chemistry must see at a glance that lime is not the cause; for, if it were, the waters would rise at boiling heat, or but a few degrees below it, whereas the warmest of thermal springs, excepting, of course, such remarkable examples as the Geysers, which are true aqueous volcanoes, do not rise beyond a point at least 50° under boiling heat.

Wherever we penetrate the crust of the earth, increase of temperature accompanies increase of depth. Mining, quarrying, and boring operations offer the best possible opportunities for the determination of this rate of increase. In the Artesian well at Grenelle, the temperature is equal to 84° Fahrenheit, at a depth of 1230 feet, and this in winter, when the air at the surface is not higher than 28° or 30°. Mr. Fox, of the United Mines, in Cornwall, has furnished some interesting details of the increase of temperature downwards indicated by the springs of those mines. The mine of Gwennap, which yields abundance of copper ore, has a vast number of warm springs; one of these, which rises at a depth of 200 fathoms below the level of the sea, discharges 94 gallons a minute, at a temperature of 106½° Fahrenheit, while, on the other side, is a spring which discharges 30 gallons a minute at the temperature of 97¾° Fahrenheit. The air near both these springs was found to be at 104½°, and the highest temperature of the air hitherto experienced 106°. Nor are such thermal fountains scarce. They abound in every region of the globe, show everywhere an affinity for granite, and have a regular increase of temperature proportionate to the increase in the depth of their source.

But the most specific, because utterly removed from the region of partial influences, is the argument deduced from cosmical phenomena; the figure of the earth, the motions of the moon, the comparative amounts of heat radiated from the sun, and the observed temperature of the earth. There is scarcely any one of the great propositions in Astronomy but may be made directly or indirectly to illustrate this problem of internal heat.

Had the earth been solid when it first began to rotate on its axis, it must necessarily have preserved to the present day its original figure, notwithstanding its rotary motion.

But if originally fluid, it must, under the influence of rotary motion, assume a figure of equilibrium—a figure expressive of the mean between its tendency to cohere, and the operation of centrifugal force to destroy its cohe-



Exaggerated Outline of the Earth, to show it as an oblate spheroid.

rence. Such a body, having a capability to yield in its outline, would, when made to rotate, become depressed to a certain extent in its axis of rotation, and to the same extent expanded at the equator. When the equilibrium had been attained, the mass would remain in the form of an ellipsoid. Now facts just agree with theoretical deductions: the earth has a larger circumference at the equator than at the poles by at least twenty-six miles; therefore we may fairly assume that the earth was originally fluid, its fluidity being the result of an intense heat.*

Let us admit that originally the earth was in an incandescent state; that in process of countless ages the outer surface cooled by radiation, and so gave rise to the formation of a solid crust; that within this crust a heated mass of fluid material was inclosed, and that this is not yet sufficiently cooled to assume a solid form. The consequence of the theory will be, that we shall observe various evidences of the occasional escape of heat from within; that wherever fissures, cracks, or perforations occur in the shell inclosing the hot material, the escape of fire, the rending of the crust, and other similar phenomena, will be manifested. We have only to take the converse view to be assured that boiling springs, earthquakes, and volcanoes are but several evidences of the existence and occasional escape of internal heat.

We need not rest, however, with the mere determination of the fact; we may, with some accuracy, measure its force, its amount, and its comparative duration during time, and even make some sober conjectures as to its history in the future.

What is the rate of increase of heat downwards? Kupffer estimated the ratio of increase at Grenelle to be 1° for every 37 feet; the Durham and Northumberland mines give 1° for ever 44 feet; the lead mines of Saxony 1° for every 65 feet; and the mine of Dolbouth, which is 1380 feet in depth, 1° for 75 feet. The best estimates, however, are those deduced from a comparison of a large number of results, and these give the rate of increase as being equal to 1° of Fahrenheit for every 45 feet of descent. Looking to the result of such a rate of increase, it is easy to see that at 7290 feet from the surface, the heat will reach 212°, the boiling point of water. At 25,500 feet it will melt lead; at 7 miles it will maintain a glowing red heat, at 21 miles melt gold, at 74 miles cast iron, at 97 miles soft iron, and at 100 miles from the surface all will be fluid as water, a mass of seething and boiling rock in a perpetually molten state, doomed possibly never to be cooled or crystallized. The heat here will exceed any with which man is acquainted; it will exceed the heat of the electric spark, or the effect of a continued voltaic current. The heat which melts platina as if it were wax is as ice to it; could we visually observe its effects, our intellect would afford no means of measuring its intensity. Here is the region of perpetual fire, the source of earthquake and volcanic

* Sir John Herschel.

power, the abode of forces which only hint of their being by the exhibition of marked phenomena on the surface.

> "When the Cyclops o'er their anvils sweat,
> And their swoln sinews echoing blows repeat,
> From the volcano gross eruptions rise,
> And curling sheets of smoke obscure the skies."

Yet a thickness of 100 miles in the crust conveys but little idea of strength to resist pressure from without and within. To a globe of 8000 miles diameter, such a crust will be proportionately much thinner than the rind of an orange, and hence but a delicate beam between the opposing forces fighting for a balance. Its thinness, indeed, renders easy of explanation the phenomenon of earthquakes, for all below being in a state of commotion and ebullition, any change upon the surface of the earth, acting on a crust so thin and hollow, would cause rents and fissures, through which the fire would burst and rage upon the surface until the falling masses closed the chasm again. What agent is there to produce such a change upon the surface? What agent of sufficient force to splinter a roofing of 100 miles' thickness? This soft, invisible, yielding, and embracing atmosphere, fanning the cheek with coolness, kissing the spring daisy as it dances over emerald meadows, or tearing up forests by the roots and hurling their timbers to the skies! This atmosphere is the essential agent, powerful for all purposes of disturbance, and ever ready to bring its power into operation. On every square inch of the earth's surface the atmosphere presses with a weight of 15 pounds. On every square foot the pressure amounts to 2160 pounds, or one ton nearly. Over the whole earth, therefore, the pressure of the atmosphere is equal to 12,043,468,800,000,000,000 pounds. Suppose the barometer to fall two inches over 100 miles of country, that fall represents the removal of 1,858,560,000 tons of pressure. The expansion from within continuing the same, will not the equilibrium between the heat within and the air without be at once destroyed? Can we wonder that Typhæus, panting and struggling with the weight of hills and plains upon his heart, will stir himself afresh as the weight of his burthen lessens?—that, indeed, the internally heated materials, no longer held down by the full pressure of the atmosphere, will heave up the crust, and cause crackings of the surface and earthquake commotions? that in the explosion cities will fall, hills be swallowed up, and plains elevated? that sheets of steam, escaping from the newly opened vents, will roll over the undulating surface? that convulsions of all kinds will occur, until, by the return of things to a balance, tranquillity is restored? One simple general fact corroborates this hypothetical view of the production of an earthquake, and it is this—that a *fall of the barometer* invariably precedes the convulsions of an earthquake.

Many inquirers, who have seen the necessity of admitting the theory of Internal Heat, have, after conviction, suffered many pangs in the contemplation of the possible consequences of the theory. If the earth is steadily parting with heat, will it not at last cool down into a lifeless frozen crystal, the abode no longer of life and beauty, but of death in his most hideous form? Let us never fear consequences, but repose faith in the perfection of the entire scheme as an evidence of the constant protection of an universal Father. The early astronomers feared consequences, and built up their theory of the destruction of all things under the necessities of perturbation; but in the progress of mathematical astronomy it has been shown that perturbations are compensatory, and have no influence on the term of existence allotted to the bodies experiencing them. How fast, then, does our earth cool? how rapidly does it approach to the supposed state of a lifeless crystal?

If the earth, in its present condition, were projected into a medium having a temperature of 58° below zero of Fahrenheit, it would not cool more in 2,000,000 years than

a globe 1000 feet in diameter would in one second of time; for how many ages, therefore, has the cooling process gone on, to bring it to its present condition of greenness and fertility—its once confused and cloudy vapours condensed into seas and lakes, and its axes capped with everlasting snows!

It must be confessed that we have no definite data by which to determine how many *eons* must elapse for the cooling of the entire globe to the present general temperature of the surface, nor can we say at what rate it parts with heat. The earth may be said to weigh about three thousand six hundred and fifty-two millions seven thousand and ninety-two billions of tons.* How long would a globe of such a bulk, if heated to the temperature of melted iron, and exposed in a medium at 0° of Fahrenheit, require to cool down to that same point on our thermometric scale?

The late M. Arago, in one of his brilliant scientific contributions to the *Annuaire*, furnishes a proof, deduced from the moon's motion, that the general temperature of the mass of the globe has not varied the tenth part of a degree during the last 2000 years. Reducing his ample explanations into a small compass, the argument takes shape as follows:—

Suppose a heavy mass were adapted to each radius of a wheel, so that we could slide the mass from the extreme end of the radius up to the axle. If the masses are set near the axle, a certain force would be required to give the wheel a rotation of (say) one revolution per second. Move the masses to the outer extremities of the radii, and though the total weight of the apparatus will not be changed, yet a greater force will be required to give, as before, one revolution per second. It follows, therefore, that, as to turn a mass of a given weight with a given velocity, the force must be increased as the elements of weight are removed from the axis of rotation; so, with a constant force, the rotary velocity of the mass will be retarded in proportion as its different particles are more distant from the axis. That which is true of a flat wheel is, in this case, also true of a spheroid, such as the earth, which rotates on its axis by virtue of an original impulse.

The materials of which the earth is composed expand by heat and contract by cold, and if contraction take place, the rotation on its axis must of necessity be increased in velocity. Hence the rate of the earth's rotation is at all times a measure of contraction or expansion of its bulk. The duration of the revolution is an unit of time, used by astronomers in all ages as the basis of the boldest inquiries and the most sober predictions, and may be used here to determine if any change has taken place in the heat of the globe during 2000 years. The ancients knew nothing of the thermometer, and hence have bequeathed no data for determining changes of heat, but they were accurate in their measurements of time.

Amongst the uses made by the ancient astronomers of the unit of time afforded by the rotation of the earth, was that of measuring the revolutions of the moon. The school of Alexandria has left materials by which to deduce the velocity of the moon in past times with the greatest exactitude. The Arabian astronomers have furnished similar data for the time of the caliphs, and there not, says Arago, a single catalogue of modern observations in which the moon's mean motion during a sidereal day is not given. Now the arc passed over by the satellite in that unit of time is found to be precisely the same, whether deduced from the Grecian, Arabian, or from recent observations; the phenomena of perturbation proper being, of course, left out of the deduction. Hence the sidereal day has been precisely the same at all

* This is the result of a rough calculation, made on the basis of Cavendish's pendulum experiment. I have lost my original memorandum of the calculation, and have now grave doubts of its accuracy.

three periods—it has for at least 2000 years designated an equal space of time, and of course during the same period the velocity of the earth's rotation has remained constant.

But observe with what precision this fact may be measured by the true philosopher. Let us suppose, says Arago, the mean temperature of each radius of the globe to have increased 1·6° Fahr. in 2000 years, and assume the average dilatation by heat of the substances composing the mass to be the same as that of glass, that is, about $\frac{1}{100000}$ for each degree; a diminution of 1° would consequently have occasioned one in the dimensions of the spheroid of $\frac{1}{100000}$, which, according to dynamical theory, would produce an acceleration in its velocity of rotation of $\frac{1}{50000}$, which would shorten the sidereal day by 1·7″. But since the time of Hipparchus, the sidereal day *has not varied the* $\frac{1}{100}$*th of a second*, a quantity 170 times less than 1·7″. Hence the change of temperature assumed above is 170 times greater than the observations on the length of the sidereal day admit of its having been; and we may conclude that the mean temperature of the general mass of the earth has not varied $\frac{1}{170}$th of a degree in 2000 years.

If the cooling process takes place so slowly, how long has it been in action to have produced its present result? The reason leaves the conjecture to imagination, and imagination, unequal to the conception of periods for which ordinary units of years, or even millions of years, afford the elements, abandons the speculation in despair. If we cannot look back, dare we look forward for a period when, however slow the loss of heat, it shall escape at last, and leave the earth frozen, arid, lifeless? or, shall we seek for some law of compensation, such as the astronomer finds in the motions of the planets, and which shall preserve the constancy of its perennial warmth and the continuance of its gay circle of seasonal changes, and flowery forms, and living and happy creatures? Will the earth powder away under the pulverizing fingers of Time, or maintain for ever the glory of its warm seasons and the freshness of its belt of flowers? Will the fire expend its force, and earthquakes cease for ever? or will the same round of changes go on eternally, swallowing cities in the embrace of hills, and swamping villages in burning seas of lava? The fact is not isolated but universal. The moon is essentially a volcanic body as regards the configuration of its surface. The lunar craters are vastly larger than those of the earth. Tycho, as cited by Mrs. Ward in "Telescope Teachings," having a diameter of fifty miles, while others exceed even these great dimensions. Sir John Herschel and other observers have noted what appeared to be evidences of existing igneous action; but Mr. Nasmyth's view is now generally adopted, that volcanic action has ceased on the moon for thousands of years. Suffice it, that the evidences of fire are there to give it an immediate physical relation to the earth we inhabit. The planets are the same, bulged at the equator, as though their inner parts were mobile, and yielded to the whirling force which spins them round and round. The heat is there, preserving summer verdure, and when the sun shines not, keeping them rotund and fertile ever; retarding the tendency of matter to slide back into a crystalline form, lifeless, shapeless, and dejected. What power the sun has in warming the earth's crust; how the forces of heat within and sunshine without balance each other on the surface; how modern geological changes, not of a volcanic nature, depend on internal expansions; how the temperature of space operates in disturbing or preserving an equilibrium, and a hundred other speculations, spring out of these conclusions on the existence of an elevated temperature in the interior of the globe. As science perseveres in her daily work of recording and comparing facts, no doubt many of these problems will be elucidated, and if material Nature is constant in its operations during

time, man, a spiritual spring of knowledge, attains a higher and a higher elevation as increase of wisdom enhances the force of his mental impulses.

That the earth *has* cooled since the days when the igneous rocks first assumed a solid form is certain, else it could never have been peopled with its present congress of created creatures; but that it should ever cool so far as to become a frozen mass is matter of conjecture. Respecting the past, we have physical evidences and written records; respecting the future, we have only the word of Revelation, and that is all we need for an assurance that the earth will not pass into frigidity, but have an end of its present days through the same physical influences which have given it its present geographical configuration.

Theology is not the province of this work, else we would apply this theory of the internal heat of the earth to the illustration of those passages in Holy Writ which proclaim that the earth shall terminate her history in fire, "in the which the heavens shall pass away with a great noise, and the earth also, and the works that are therein shall be burned up." The source of the combustion is beneath our feet; we tread on the roof of the blast furnace, which is ready to let loose the devouring flame, when God wills the dissolution of the system of being into which He hath breathed the breath of life. This is one more "Testimony of the Rocks" to the truths set forth in revealed religion. If we do not follow this branch of the subject into detail, we must nevertheless accept the lesson drawn from it by the apostle—"Seeing that all these things shall be dissolved, what manner of persons ought ye to be in all holy conversation and godliness; looking for and hasting unto the coming of the day of God, wherein the heavens being on fire shall be dissolved, and the elements shall melt with fervent heat."

SHIRLEY HIBBERD.

NOBERT'S TEST-LINES.

"How much does my microscope magnify, with its various powers?" is a question of interest to all who purchase or use one of these instruments. The beginner is mostly pleased with the number of times he can magnify an object; those who have become habituated to the instrument by long practice regard this as a very small consideration, and look to how much of structure can be shown by the least amount of enlargement. But there are cases where this latter quality is as such essential; for if we have objects so small as to require high powers to show them as a whole, and these composed of a great number of still finer parts, it is obvious that very high powers must be used for observations on their minute details. Standards by which to estimate the magnifying powers of glasses by different makers have been found in the scales of moths, amongst which those of the common clothes-moth, from their minute size and the regularity of their markings, have been held in high estimation. As in course of time glasses were made of greater power, other "test-objects" were sought for, and the scales of Lepisma, and afterwards of Podura, came to be used; these being replaced by certain of the Diatomaceæ, on the discovery of the exquisite delicacy of the sculpturing on many of their valves. Many an enthusiastic microscopist is yet to be found who regards the successful resolution of the striæ on some difficult diatom as a great triumph, worthy the bestowal of time and patience without end. But a difficulty occurs with all natural objects, that no two are alike; some, of the same kind

and even from the same source, being marked with twice or thrice the degree of fineness of others, to remedy which it was necessary that some absolute standard should be obtained. The application of the principle of machine-ruling led to its solution in the subject of the present paper.

Slips of glass ruled with lines, 100 and 1000 to the inch, are in common use, and are invaluable in ascertaining the degree to which any object is magnified; without them we should be unable to estimate the closeness of the ruling in M. Nobert's wonderful productions. M. Froment, of Paris, succeeded in ruling lines on glass 25,000 to the inch; in this path he was followed by M. F. A. Nobert, of Barth in Pomerania, who sent to the Great Exhibition, in 1851, some slips ruled with bands of lines of different degrees of fineness; in the first band the lines were 11,000 to an inch, in the last 50,000 in the same space. The bands in these his first-exhibited productions, were ten in number, and having been separately estimated by several observers of high repute, these numbers are generally accepted as correct.

M. Nobert's later productions surpass even these; as at present supplied, they consist of a slip of glass (Fig. 1), on which, by

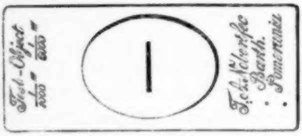


FIG. 1.

careful observation with the naked eye, may be observed what looks like a single shadowy line, sparkling in bright light with the play of prismatic colours. By moderate power (50 diameters), with good glass and careful illumination, twenty distinct bands may be counted, the finer, however, very shadowy and evanescent. With 100 diameters, the four coarsest should be shown in distinct lines (Fig. 2); as the power is increased, more and more of the bands will be resolved, till

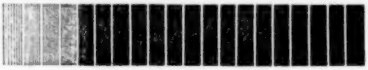


FIG. 2.

with 500 diameters the separate lines composing all but one or two of the finest of the bands should be clearly seen: for satisfactory resolution of the latter a power of 800 diameters, with most skilful management of the accessories, is required. Fig. 3 may serve to give some idea of their appearance then,

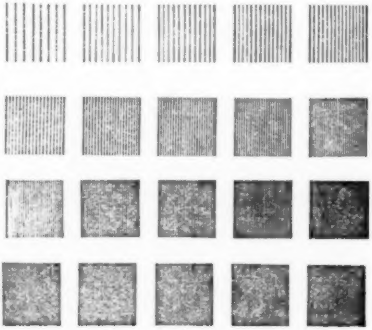


FIG. 3.

though it is impossible to imitate closely the exquisite delicacy of the lines.

The difficulty of viewing, and still greater of counting, lines so close, is such that observers are not at present equally agreed in their measurements of the later series. As furnished by a friend, in whose accuracy we place great reliance, from his extensive practice in such investigations, the range is from 13,000 in band No. 1 to 80,000 in band No. 20.

The extreme delicacy and regularity of these lines, with their closeness, are calculated to excite admiration in the highest degree. We run over the numbers glibly, as we do the "millions of miles" of the astronomer, but to form any conception of lines,

80,000 in the inch is about equally difficult. It is interesting to observe here that the best authorities are agreed in estimating the lines on the most finely-marked of the Diatomaceæ yet resolved, at about the same figure, 80,000 to 85,000 in the English inch; and although it may be rash, in view of the strides made during the last few years, to say it seems as if it might have been written with regard to these,

"Thus far shalt thou go, and no further,"

yet it does appear as if the probabilities pointed that way. Rays of light won't go through everything; object-glasses have already been made with angles of aperture that cannot be exceeded.

As tests of *aperture*, Nobert's Lines are the best, but since these lines may be seen by glasses of large aperture, yet out in the centring, faulty in the fitting, it is evident that something more is required than the showing these well, before an object-glass can be pronounced "first-rate." And, after all, the showing the markings on fine-lined objects is only one of the purposes of a microscope; perhaps it is not too much to call it, for real service, one of the least. If information be required on structure, on the component tissues of an object under examination, to be able to look through some depth of substance is absolutely essential; and it is satisfactory to observe that the efforts of makers are now being directed to the production, at reasonable prices, of first-rate object-glasses, with moderate angular aperture, rather than to such as possess little working value beyond showing "*Nobert's Test-Lines*," and other fine-lined objects.

TUFFEN WEST, F.L.S.

PRACTICAL PHOTOGRAPHY.

PHOTOGRAPHY has now fairly taken its place as one of the useful arts; the purposes to which it is applied are almost innumerable, and it would be difficult to name an art or a science which is not largely indebted to it. The chemistry of photography is now so well understood, that pictures produced by it, if prepared with proper care, and according to approved formulæ, may be considered as permanent as drawings or paintings.

There appears now to be a slight pause in the progress of photography. Its general principles are well known. Thousands of able chemists and enthusiastic photographers have lent their aid to bring it to its present perfection. No *great* discoveries have been lately made, and the energies of all are occupied in perfecting and simplifying the processes already known. Shall we continue to wait until some grand discovery so far eclipses our present performances as to make useless our present apparatus and materials? Or shall we not rather bring into general use photography as it now is, and avail ourselves of its assistance for a variety of purposes? To the artist, the geologist, the botanist, the mechanist, etc., how valuable is photography. Who can copy a landscape with such fidelity, a building with such fine perspective, a model, a machine, a fossil, a plant, a map, a drawing, a manuscript, a coin, with the same accuracy as the camera? Once obtain a negative, and it may be reproduced, like an engraving, to any extent. Every lover of science should understand photography sufficiently to enable him to use it for these, and a variety of purposes, which are almost of daily occurrence, and it is for the use of such this sketch is intended; not to teach *photographers*, but to endeavour to show that any one with moderate patience, and the use of his fingers, may be enabled, in a very short time and at a very small cost, to learn sufficient of the art to practise it with success, and to make use

of it as he would the art of drawing, whenever he may have occasion. The writer, for his own pleasure, and that of his friends, has made use of photography in many ways besides the ordinary uses of landscape and portraiture. Amongst them may be mentioned copying insects, ferns, mosses, fossils, shells, ancient deeds, seals, models of portions of the moon's surface, letters, manuscript music, rare engravings, paintings, scientific instruments, machinery, etc.

Books on photography generally treat of all the known processes, and the reader is bewildered, not knowing which of the number to choose, and too often the manuals, which profess to be simple, are written by persons who know little of the subject, or whose object is to recommend some particular maker of apparatus and chemicals.

Among the many processes two are most generally useful, viz., "wet collodion," suitable for home-work, and "collodio-albumen," for use in the fields, or when from home. The former requires the chemicals and apparatus at hand; in the latter, the camera and sensitive plates are alone required for taking the pictures, the preparation, etc., being performed at home. The printing process, which is used for both, and which is very simple, will be explained afterwards.

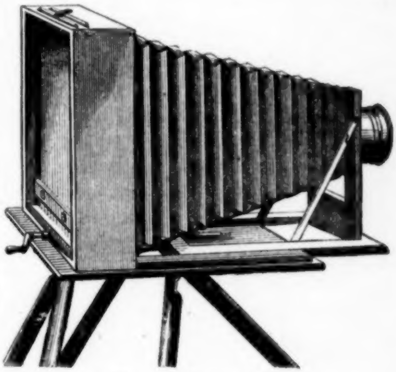
THE OPERATING ROOM.

As the collodion process is the basis of the other, it is necessary to learn it first. The following will be required :—

A small room, the door of which fits tolerably tight, having a small window, if possible, looking north ; a light deal frame (say one inch in thickness) should be made to fit the window, and yellow paper stretched over it, and pasted to the edge on each side, so that when dry there will be two sheets of paper tight on the frame, and a space of an inch between them. Three or four buttons will fix this firmly to the window, and it can at any time be removed in half a minute. No light must be admitted to the room except through this yellow screen. Any apertures, such as the key-hole of the door, admitting white light, must be carefully covered. Under the window there must be a sink lined with lead, a pipe to carry off the water, and a water-tap above, a shelf or two on each side of the window, and a bench or table in the room. In case a water-pipe cannot be conveniently brought into the room, a large jar of water, covered with a lid and a small jug to lade it out with, will answer every purpose. In the arrangement of the operating-room, any modification may be made according to circumstances, the writer only gives his opinion as to what he considers most simple and convenient.

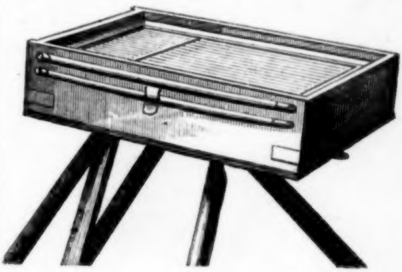
The most useful camera for home-work is one taking pictures 11 × 9 inches of the ordinary double-body form. When closed, to be 14 inches, and, when fully extended, to be about 26 inches in length, the frame to have adapting panels for the smaller sizes of plates, 9 × 7, 7 × 5½, 5 × 4, etc. One of Rosse's smallest orthographic lenses will answer almost every purpose that can be required, even taking good portraits, and will also be the lens most useful for the collodio-albumen process, hereafter to be described. A strong stand for the camera will also be wanted. There is a very good French-made stand, with arrangements for elevation, depression, and lateral movement, which is exceedingly well made, and very reasonable in price.*

For those who do not wish to copy an object larger than about one-third the natural size, and who also wish to practise landscape



Kinnear's Camera open.

photography, it would save expense to procure at once a portable camera instead of the one recommended, which will answer both purposes, either on Captain Fowkes's, or Mr. Kinnear's plan. Each of these has its ad-



Kinnear's Camera closed.

vantages, but the latter is the lightest and least complicated. Captain Fowkes's camera is to be procured from Ottiwell and Co.,

* The stand mentioned, and porcelain developing cup, may be procured at Mr. Pyne's, Piccadilly, Manchester.

London; the other from Mr. Mudd, of Manchester.

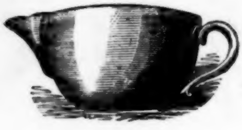
The cheapest and best plan for an amateur, who does not wish to make photography a *study*, is to go to some respectable dealer in photographic chemicals, and procure all the materials required, as nearly as possible, ready for use. The time was when every photographer prepared his own chemicals. Gun-cotton, and even æther, were his own manufacture (like the artist of the last century, who had to make his own colours), but now they are to be procured good and cheap, and the time formerly occupied in their manufacture can be much better employed.

The chemicals required are—

Nitrate of silver solution prepared for negatives . . .	40 oz.
Nitrate of silver fused . .	1 oz.
Ponting's or Thomas's collodion (negative)	8 oz.
Protosulphate of iron crystals	4 oz.
Pyrogallic acid . . .	1 oz.
Glacial acetic acid . . .	4 oz.
Alcohol	4 oz.
Bottle of French varnish.	
Æther	4 oz.
Hyposulphite of soda (in jar) .	1 lb.

The apparatus required are—

Glass bath and dipper for plates, 11 × 9.
Globe plate-holder.
Collodion bottle of 4 oz.



Two porcelain developing cups.

One, two, and ten-ounce glass measures.

Two earthenware or porcelain dishes, 12 × 10 inches.

Scales and weights.

Glass plates and plate-boxes of the sizes required.

India-rubber finger-stalls for thumb and finger.

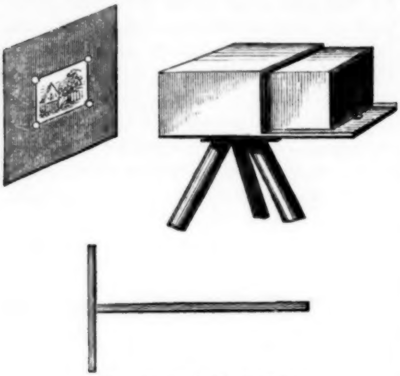
Clean the glasses with a little Tripoli powder and spirits of wine; wash them well, and polish with a soft cloth, and stow away in the plate-boxes till required. They should be repolished on the day they are to be used. Having procured the necessary materials and apparatus, fix the camera on its stand opposite the object to be copied, in a good light, and move it as near as may be found requisite to take a picture of the size wanted and focus accurately, so as to get an image on the ground glass perfectly sharp; a piece of black velvet makes a good focussing cloth. In copying a map or picture, it is very important that the plane of the camera should be exactly parallel to it, otherwise the image is distorted. This is not an easy matter to accomplish by the eye alone; a long T square, with the top set against the face of the picture, will show at once whether the sides of the camera are at right angles to it or not.

Globe Plate-holder.

Collodion Bottle.

All being ready in the operating-room, the plate must be taken up by the plate-holder, and its surface dusted with a large camel's-hair brush, and collodion poured on its centre, run round gently to each of the corners, and poured off again into the collar surrounding the mouth of the collodion bottle, from which it will flow into the bottle again; the plate is to be held with the corner downwards, from which the collodion has been poured, and a slight rocking motion given to it, to prevent the formation of lines in the film. When it has set,

which it will do in a few seconds, place tne piate upon the dipper, and plunge it into



Focussing with the T Square.

the silver bath; raise the dipper once or twice, and then allow it to rest for a minute or two.

The dark frame should be quite free from dust, and a strip of clean blotting-paper, half an inch broad, laid at its lower edge, for the plate to rest upon; it is very convenient to have a string with a number of these strips attached, hung up ready for use; they prevent the frame being spoiled, and also the negative from staining.

The finger-stalls should now be placed on the thumb and first finger of the right hand, and the plate lifted from the bath; if it looks greasy on the surface, it must be returned again for a short time; if the solution flow evenly over, it is ready for removal. Take it from the dipper with the finger and thumb, and let the lower edge rest on a sheet of blotting-paper, whilst the superfluous silver is wiped from the back; then place it in the dark frame, take it to the camera, lift the shutter, and remove the cap from the lens. The length of time for exposure varies with the subject, the light, the season, time of day, and aperture used, etc.—so much, that no rule can be given; half a minute may be tried in the first instance, and more or less exposure given afterwards as required. The cap must be replaced, the shutter put down, and the frame again taken to the operating-room. The following solution must be prepared beforehand; it will keep good a few days:—

DEVELOPING SOLUTION.

Pyrogallic acid . .	2 grains.
Glacial acetic acid . .	30 minims.
Water	1 oz.

In very hot weather, this may be mixed with an equal quantity of water before using.

Remove the plate from the frame with the plate-holder, hold it in a horizontal position, and pour gently on it at one edge from the developing cup as much of the solution as well covers it. The image will probably begin to appear in a few seconds, and continue gaining intensity for some minutes. Keep the solution in motion, and when the negative has gained sufficient intensity, pour it off, and wash well with water; then place it in a dish containing—

Hyposulphite of soda	4 oz.
Water.	10 oz.

When all the creamy colour has disappeared, wash again well with water, and rear up the negative to dry, which should be accomplished rather soon, or it is apt to lose a little of its intensity. Should the plate have been under-exposed, the contrasts will be too strong in the negative, and a want of half-tone. If over-exposed, the image will be flat, and wanting in intensity. If the exposure has been right, and the operation properly performed, the result will be a negative capable of producing any number of prints. When dry, the surface of the picture must be protected by pouring on it whilst warm the varnish prepared for the purpose, and allowing it to harden.

The whole operation is exceedingly simple, and can be performed in much less time than is taken in describing it. If good materials

be used, and proper care taken, success is almost certain, even on the first trial. Much depends on order and cleanliness, and most of the failures are attributable to the neglect of one or other of these photographic virtues. There is not the slightest occasion to stain either the dress or the fingers in any of the operations. Those who do so are generally unsuccessful.

In this limited space it would be impossible to enter into the causes of certain kinds of failure and their remedies. It is best not to anticipate what may, perhaps, never occur, but to state with confidence that any one determined to learn the art of photography may, in a very short time, become a successful operator. The mode of taking direct positives, and of developing negatives with protosulphate of iron, are also omitted. Those who seek information on these, or any other processes, will find Hardwick's "Photographic Chemistry" a clear and safe guide, but the beginner must not be startled at the size of the volume, nor think it necessary to study the whole of it before he can take photographic pictures.

JOSEPH SIDEBOTHAM.

Manchester.

THE ODOURS OF FLOWERS.

THE cultivation of a garden, and especially that of flowers, is the one certain mark of civilization, no nation in a state of barbarism ever attaining to it; nor is it less universal than certain, for all civilized nations seek pleasure from this source, and the love of flowers appears to be common to all except the most degraded. Appealing to the eye by the beauty of their forms and the splendour of their hues, and to the sense of smelling by their varied odours, they afford pleasure at the same time to two of our five senses, and have thus become the theme of the poet, and the admiration of all to whom the works of creation are a source of contemplation and delight. Even the Saviour himself did not withhold his testimony to their loveliness, but declared that Solomon in all his glory was not arrayed like "one of these."

Our present object, however, is not to call attention to the beauty of flowers as objects of sight, but to their odours—to those subtle emanations which are apparently intangible, and which yet affect us so strongly, and in general with so much pleasure. It is true there are some individuals in whom the powerful scent of certain flowers, as of the hyacinth, causes faintness; and there are some flowers the scent of which affects different persons in a dissimilar manner. Thus the blossoms of the Portuguese laurel, which to many are agreeable in the open air, are to others so much the reverse as to cause a feeling of positive disgust. These differences must be attributed to some variety in the nervous sensibility of different individuals that is not well understood.

Apart from the immediate purpose of *utility*, to which each of our several senses is adapted, they at the same time subserve to the pleasure of their possessor, and some of them have for this object alone been considerably increased in delicacy and power by careful training. This has been more particularly the case with the eye and the ear, but there seems no reason why the sense of smelling should not be subject to the same process, and thus become able to discriminate odours as perfectly as the ear judges of sounds, and the eye of forms and colours. This may indeed appear almost a necessity in the present day, when the progress of organic chemistry already enables the skilful operator to produce *imitations* of several well-known

perfumes, no less than that compound of "villanous smells" that is the more usual product of his laboratory.

With merely a passing reference to the "Odours of Eden," which breathed around our first parents in their delightful abode, we may notice that perfumes have been in use from the earliest ages, not only as a source of pleasure, but also as a supposed means of repelling diseases, and as auxiliaries in religious ceremonies; for which last purpose incense is still used in Europe, whilst in China the "joss-stick" is employed in the temples of their various idols.

It is not possible to convey in words a description of the various odours which affect us, either pleasantly or otherwise, and we can no more imagine a new one than we can picture to ourselves a new colour. Every odoriferous flower has its own peculiar scent, and though the variety is almost endless, it is probable that (chemically considered) they are all similarly composed, and that their ultimate elements are few.

That these odorous emanations are capable of a very wide diffusion, is evident from the distance at which they are perceptible. The fragrance of newly-mown hay is an instance of this, and a single flower of the Magnolia glauca, when first expanded, will fill a large apartment with its odour. Certain trees also, when under the influence of warmth and light, diffuse their emanations to an immense distance; the coniferæ or firs being amongst the most noticeable in this respect. Where large forests of these are found, their exhalations have been perceptible at sea when the land was far beyond the limits of sight; it is even said at the distance of 100 miles. Some flowers only emit their perfume at certain hours, and at others appear almost or quite scentless; as the night-blowing stock, which during the day is without odour, but at sunset emits a delicious fragrance.

The pleasure derived from the fragrance of flowers has induced the endeavour to separate the odoriferous principle from them, so as to have the perfume when the flowers are unattainable. This odoriferous principle, or substance in which the odour resides, is in most cases a volatile oil, to which the name of *otto* or *attar* is given, and this is usually extracted by distilling the flowers with water, with the steam of which the volatile matter passes over and is condensed. The extent to which this process is employed, both in our own and in other countries, is much more considerable than is generally supposed; several large establishments for the especial purpose existing in the immediate neighbourhood of London, in localities where the soil appears most suited for the growth of the various plants. It may surprise some of our readers to learn that in these "flower farms," as they are sometimes called, may be seen fields of several acres planted entirely with roses, and others still larger and more numerous devoted solely to the growth of lavender and peppermint—plants which produce in England, and especially in the counties of Surrey and Hertford, an oil so much finer than can be procured from the Continent, that it is worth eight times the price of the foreign. About 6000 pounds of oil of lavender are annually produced in England from these farms Violets also, the "coronets of April," are cultivated to a large extent, one grower of these general favourites having no less than nine acres of ground entirely covered with them, and others may possibly have even more than this.

It is, however, in the south of Europe, and especially in the neighbourhood of Grasse and of Nice, that the cultivation of flowers for the sake of their ottos is most extensively practised, the warmer climate being more favourable to their growth, and causing them to yield a larger product of the article sought. At Cannes are grown roses, tuberoses, jasmine, and neroli; and at Nismes, thyme, rosemary, and aspic; whilst Sicily yields

lemon, bergamot, and orange. The amount of essential oil procurable from these different flowers and plants varies considerably, and it is remarkable that the most fragrant do not always yield the largest quantity. Thus, whilst 112 lbs. of lavender flowers afford about thirty ounces of otto, the same weight of rose leaves only furnish two drachms, and of violets not more than half a drachm, which accounts for the high price of some of these products. Some idea may be formed of the quantity of the various perfumes consumed in this country by the fact of the duty levied on their importation (including that on the spirit used in manufacturing them into essences) amounting annually to £40,000—a large sum, it has been remarked, to expend for perfuming Britannia's pocket-handkerchief. Of this about £8000 is derived from the favourite Eau de Cologne.

The oil or otto of some of the more delicately-scented flowers is so easily decomposed, that the process of distillation mentioned above cannot be employed for procuring them, the heat of the boiling water destroying their fragrance. Other methods are therefore resorted to, of which one is the infusion of the flowers in warm alcohol, fresh quantities being repeatedly used till the spirit acquires a sufficiently powerful scent. Another, and still more delicate process, called "enfleurage," is founded on the facility with which most oils and fatty substances absorb the aroma of flowers, and is thus conducted:—Square frames, about three inches deep and of considerable size, are provided, each having a glass bottom. On this is spread a layer of purified fat, or lard, about a quarter of an inch in thickness, on which the flowers are thickly strewn, and the frames being placed over each other so as to exclude the air, the whole is left for some days, during which the fat absorbs the volatile otto. The flowers are renewed as long as the plants continue to bloom, or until the pomade is sufficiently fragrant. It is from these pomades (chiefly made in France) that some of our most delicate perfumes are obtained. Being first cut into small pieces, they are infused for some time in highly rectified spirit, which gradually extracts from them the otto they had imbibed, and, being then poured off, constitutes the volatile and fragrant liquid known as an essence of the flower originally used. The fatty substance, which still retains some portion of the fragrant matter, is then carefully melted, and forms a pomade fit for applying to the hair.

Although, in general, the odours of which we have spoken reside in the flowers, yet it must be observed that in many plants the leaves are nearly as fragrant, and in some (the sweet-briar, for instance) even more so; whilst in other cases it is the roots, fruit, or seeds in which the odoriferous principle is found. In all cases similar means of extraction are employed, varied, of course, according to the skill of the operator. It is worthy of remark that the wall-flower, of which the scent is generally agreeable, has not yet been (so far as we know) subjected to any of these processes for the extraction of its fragrant principle.*

It is a curious fact, that just as the mixture of two colours will produce a new one, so the combination, in due proportion, of two or more of these ottos will produce a new odour. An instance of this effect is found in the present well-known perfume called Rondeletia, which, instead of being derived from the West Indian plant of that name, is formed by a mixture of the ottos of lavender and of cloves, in which neither of them predominates so as to be distinguishable. In making this and other similar mixtures, the relative power of each otto must be carefully observed, and by experiments of this kind we find that patchouli, lavender, neroli, and verbena are the most potent of vegetable odours, and violet, tuberose, and jasmine the most delicate.

* A scent called "Wall-flower" is frequently advertised by perfumers.—Ed.

Allusion has been made to the *imitations* of various natural odours produced in the laboratory of the modern chemist. These, differing entirely from the mixtures just mentioned, may rank among the most remarkable results of the progress of organic chemistry, which, as it advances, may not improbably succeed in producing still nearer approximations to the products of vegetation. Already we have a so-called essence of pine-apple, prepared from a mixture of sugar, sour milk, and putrid cheese, with some other materials, and an artificial essence of quince, made by treating the oil of rue with nitric acid.

There is also an artificial odour of pears, procured from the fœtid oil produced in the distillation of brandy from potatoes. All these, which, it will be remarked, are rather the flavours of fruits than the odours of flowers, are sometimes used as flavouring materials in confectionary. Hitherto no artificial preparations have been discovered that resemble in fragrance the odours of the finer and more delicate flowers, as the rose, violet, mignonette, and others; nor even in the cases mentioned is the artificial product an exact resemblance of the natural, though very nearly approaching it.

BENJAMIN ABBOTT.

COAL AND CONIFEROUS WOOD UNDER THE MICROSCOPE.

THE microscope has not only enabled us to observe the functions and structures of objects now or recently living, but it also brings under our view the structures of objects living long ages ago, and from which all life has departed. By its aid we can compare the most modern things with the most ancient, and can sometimes discover the counterpart of the life of to-day, in minute configurations of the dead, dull matter which had similar life tens of thousands of years since in the remote centuries—centuries which seem to pass back beyond all our powers of calculation, and to fade away into the confusion of primeval ages, undistinguishable save by the keen eye of the geologist.

This may be exemplified in two substances which appear as unlike in their exteriors as any two substances can appear, viz., a piece of recent coniferous wood and a lump of lignite, or brown or other coal. Let us first notice these substances separately, and then observe their resemblance, and glance at the interesting points of inquiry arising out of this resemblance, as elucidating the formation of coal. The term *coniferæ* is given to trees bearing cones containing the seeds, as the fir and pine—an order of plants of which we have some specimens growing in our own country, as the Scotch fir, spruce, larch, etc., but which is far more largely developed in other and warmer climates. The cone is a mysterious symbol in the sculptured slabs from Nineveh, now in the British Museum; and, in one sense, that strange figure which stretches forth the cone in its hand in so many of these sculptures might be called the coniferous Assyrian. In one instance, a four-winged divinity is represented as presenting the pine-cone to those who cross the threshold of the chamber near which it stands.

If we take up a piece of coniferous wood, and regard it merely as an opaque, massive object, we shall gain but little knowledge of its minute structure, whether it be fossil or recent. But if we can reduce it into extremely thin slices, and mount one of these as an object for the microscope, we shall discern more than we could have expected. A Scotch lapidary, Mr. Sanderson, seems to

have been one of the first to prepare fossil specimens of such wood (and coal) for the microscope. This task is one of some difficulty and uncertainty. To succeed in it, we must first grind a surface flat, and then with lapidary's cement fix that surface to a block of wood, by means of which the fossil can be again ground down until considered thin enough. But then it is difficult to detach the fossil from the block, and to remove the cement without breaking it. Mr. Nicol, however, adopted an easy and simple process, which consisted in cementing the flattened surface to a piece of plate-glass, by means of Canada balsam, and then grinding it down with emery on a plate of copper. The glass and cement being both transparent, the operator could determine when he had arrived at the proper degree of thinness; and when that was attained, nothing more was requisite than to polish the surface. For a long time this method was comparatively secret, till Mr. Nicol wrote a full account of all the requisite manipulations, at Mr. Witham's request, which was printed at the end of that gentleman's work, entitled "Observations on Fossil Vegetables," now a scarce book. The manipulation, however, in this kind of work is very delicate, and demands considerable skill as well as patience, insomuch that we notice that Mr. Sanderson's slices are prized to this day as of great superiority.

In pursuing the same object with reference to coal, various methods of preparing it may be adopted. Thin sections may be obtained from those kinds which have sufficient tenacity; but in proportion to the opacity of the material must be its thinness before it becomes transparent, and in proportion to its thinness is its friability: so that just when we have brought it to the necessary tenuity, it often crumbles and disappoints our hopes. Skilful practitioners* have found that if the coal is macerated, or soaked to decay for about a week in a solution of carbonate of potass, it is possible at the end of that time to cut rather thin slices with a razor. These being placed in a watch-glass, with strong nitric acid, covered, and then gently heated, they soon become brownish and then yellow; when the process must be arrested by dropping the whole into a saucer of cold water, otherwise the coal will be dissolved. Slices thus treated assume a darkish amber colour, are very transparent, and when a conspicuous structure is in the original lump they exhibit it most clearly. The specimens are best preserved, in glycerine, in cells; for the spirit renders them opaque, and even Canada balsam has the same effect.

There are instances in which the coal is so friable, that no sections can be made from it by either of these methods. In such cases it may be ground to fine powder, and the particles, after being mounted in Canada balsam, may be subjected to microscopic examination. It cannot be supposed that the result will be very satisfactory, but it may be of considerable comparative value in relation to other and more compact varieties. Even the ash of ordinary coals (obtained by burning to white ash a specimen of coal previously boiled in nitric acid, and then carefully mounting the ash in Canada balsam) often exhibits mineral casts of vegetable cells and fibres. The ash of the Welsh anthracite is useful for this purpose. It is necessary to observe that the great bulk of the coals used in our households, including all the coking varieties, the anthracite, and the coals used for steam-engines, are perfectly opaque, and can only be viewed by reflected light. On the other hand, the gas-coals (those employed in gas-works), such as the Pelton gas-coals, and those from Nova Scotia, together with the cannel-coals, brown-coals, jets, and lignites, can all be rendered more or less transparent. Hence, however many varieties

* "Micrographic Dictionary."

of coal there are commercially, there are only two kinds when microscopically regarded, viz., the opaque and the partially transparent. When suitable sections of the latter varieties of coal are made and reduced to a uniform thinness, so that if transparent they may be examined with transmitted light, by the aid of powers which magnify from seventy to three hundred diameters, they are discovered to present certain general and constant characteristic features connected with vegetable origin and structure. They are seen to be composed of three distinct materials, which differ both in appearance and in proportion. These are (1.) an opaque black substance, which corresponds in microscopical appearance and in reaction with carbon as it exists in various natural substances. (2.) A yellowish and sometimes reddish substance, the nature of which is not easily ascertained. In colour it varies from a light yellow to a bright red, or amber-coloured resinous-looking matter. It enters most abundantly into the composition of gas-coals, while the black substance seems to form the chief and almost exclusive constituent of household coals and anthracites. (3.) An earthy matter, more or less soluble in water, which it sometimes colours. It consists principally of umber. The relative proportions of this matter seem to influence the various products derived from the coal.

All the varieties of coaly substances may be classified under three heads, having relation to what we have just stated :—

I. Substances the sections of which are for the most part opaque, and abound in pure black matter. These comprehend the household, coking, steam, and anthracitic coals.

II. Three varieties of coal, consisting of—

1. Coals more or less transparent, particularly gas-producing coals, having a clear and conspicuous lustre, and a brittle, crystalline structure, such as the Pelton and Nova Scotia kinds.

2. Cannel-coals, like those of Wigan, in Lancashire.

3. Coals variously stratified, having an earthy and black opaque coaly matter, such as is known by the local term *splint*.

III. Brown coals, lignites, Bovey coal, and jets.

These latter varieties are of far inferior value as fuel, and therefore commercially worthless where good bituminous coals are available. Nevertheless they are most interesting scientifically and under the microscope; for we learn from sections of them that the changes of the vegetable matter, which have been completed in good Newcastle coal, have evidently been suspended, or only imperfectly carried out, in the German brown coal and the English Bovey coal. It may be well, therefore, to explain what these substances are, and where they are found.

Brown coal is so called from its brownish colour, and is otherwise named lignite (from the Latin *lignum*, wood) on account of its woody appearance. It is indeed like half-decayed wood; though it is more compact in some places where the vegetable remains are so well preserved, and their original structure so distinctly retained that a botanical indication is presented of the original plants of which it was composed. These consist of flattened stems crossing each other in all directions, and are either of a darker or lighter colour. They are soft and mellow in consistence when the substance is freshly quarried, but become brittle by exposure, the fracture following the direction of the fibre of the wood. Of the same character is the Bovey coal, so termed from Bovey Tracy, a village in Devonshire, where it is found. It seems to be confined in our land to that locality, but a very similar substance is found at Wettenau, in Germany, and is styled fibrous brown coal. We have in our cabinet a specimen of Bovey coal containing minute seed-vessels of plants.

All those varieties are sometimes called

the tertiary coals, from their geological position in the tertiary series of beds, and thus they are pointedly distinguished from the true and pure coals of the carboniferous series of rocks. There are many kinds of them in different countries; some which merely exhibit occasional indications of vegetable structure, and generally form throughout a stratified mass of a dark colour, possessing an earthy fracture, are hence termed earthy brown coals. Such is the coal of Meissner, near Cassel, in Germany. Other varieties, in which the fracture is shelly (conchoidal), and the structures more dense, are called conchoidal brown coals, or pitch coals. These deposits are frequently found near the surface, but in other situations at considerable depths. Tertiary lignite abounds at St. Gall, in Switzerland, and in a bed of brown coal, near that place, a singular and new species of combustible mineral (Scheererhite) has been found. The tertiary coals in the canton of Zurich are remarkable for many bones of mammifers, which are said to have been discovered amongst them, associated with which are reported bones of the mastodon. All these circumstances are interesting in connection with the origin and geological posi-

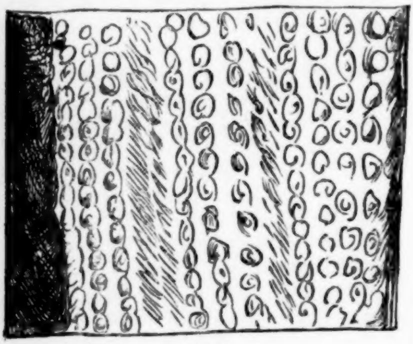


Fig. 1.

tion of the comparatively modern and imperfect coals.

Figure 1 displays a transverse section of the German brown coal, in which the woody fibres are cut through by the section transversely to their long axis. In com-

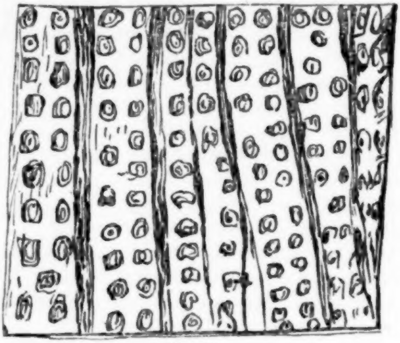


Fig. 2.

parison with this we present (in Fig. 2) a longitudinal section (parallel to a radius) of recent coniferous wood of the *Pinus strobus*. In Fig. 3 is seen part of a transverse section of the same wood, the whole section being of the same character.

Mr. Nicol refers to specimens from the coals of Nova Scotia, in the collection of Professor Jameson, "one of which," says he, "is a fossil conifer, displaying all the characters of the most perfect recent American pines. In the transverse section, the annual layers are well defined, the reticulated (net-like) texture large and perfect, and in the longitudinal section, parallel to a radius, discs occur both in single and double rows. These, as usual, are in some parts very obscure, but in other parts they are very distinct. They are circular, and some of them display at the circumference two concentric rings, and one ring near the centre. In the double rows, as in the recent pines, the discs are placed side by side, and indeed in all its characters this fossil bears a greater resemblance to some of the recent pines than anything of the kind that has hitherto fallen into my hands." The discs spoken of are also conspicuous in the section (Fig. 2), and the struc-

ture displayed in Fig. 3 is similarly, though variously, marked in several other sections in the same direction.

A longitudinal concentric section of an araucaria, from Moreton Bay, New Holland,

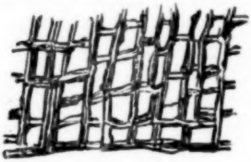


FIG. 3.

(a recent wood) is shown in Fig. 4. The celebrated Craigleith tree, found fossil in the sandstone quarry at that place (near Edinburgh) in October, 1833, is a very fine specimen of a coniferous petrifaction, and very much resembles in its general characters the

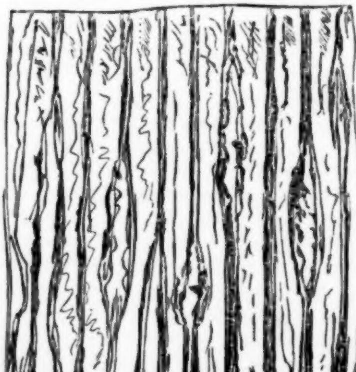


FIG 4.

araucaria of Moreton Bay. In a longitudinal section (parallel to a radius) of this tree, the vessels in general are very much distorted, and the whole texture greatly obscured; but when the vessels appear with any distinctness, they often contain discs in double, triple, and quadruple rows, though the discs are always obscurely seen. The general conclusion arrived at by Mr. Nicol, after all his examinations, is, that all the *fossils* retaining the ligneous structure in the coal, from these formations, are of coniferous origin.

Having already named cannel-coal, we may explain its character. It burns as clearly as a candle, when once ignited at a flame, and hence its name, which is a corruption of *candle-coal.* But it flies off (decrepitates) in small fragments, with a cracking noise, when flat pieces are placed upon a fire. Its colour is grayish black or brown, its lustre is resinous, and it is so compact that it can be worked in blocks and turned in a lathe, and is susceptible of a good polish. It is, therefore, often fashioned into a variety of ornaments, and has so much the appearance of jet as to deceive all but careful observers. The streak is, however, very different from that of jet. So bituminous is it, that in making coke or gas it is mixed with the smallest of the best coal. The collieries of Wigan, in Lancashire, afford considerable quantities of cannel-coal, and it is also found in pits near Coventry, and at Lesmahago, not far from Glasgow. Mr. Witham found distinct traces of organization in it under the microscope. From its compact nature

FIG. 5.

sections of it are not difficult to form, and they will reward the observer. Fig. 5 exhibits a section of cannel-coal, wherein the

transition state, in the process of retrograde decay of the vegetable tissue, is distinctly traceable, and the preserved or uncoalified vegetation is seen to pass, by insensible gradations, into the structure of cannel-coal.

We now refer to a mineral fuel, the nature of which has occasioned more curious and legal, as well as scientific, controversy than any other, and which might, indeed, be termed "Recreative Science," to the lawyers on the one hand, and to those who laugh at all science as unpractical on the other. The fuel alluded to is known as the Torbanehill mineral, and the legal question arose, whether it was a mere mineral, or whether it was coal. Many scientific men, of great reputation, had spent much time in this inquiry, previously to the trial (Gillespie *versus* Russel). Amongst these was Professor Bennett, of Edinburgh, who caused to be prepared, and carefully examined, various kinds of household coal, which might be considered as typical or standard examples. Next he examined three sections of the Torbanehill mineral, and was struck with the remarkable dissimilarity which existed between them. Numerous sections of cannel-coal were then prepared, and the difference between the appearances presented by the true coals and by this mineral having been previously determined, the Professor was readily enabled to distinguish the difference between them. Though the various cannel-coals, and one especially, approached in structural character to the Torbanehill mineral, yet there was at least one element which characterized all the coals, and was absent from this mineral. Several other inquirers contended that "the Torbanehill mineral is widely different from every kind of coal." It is also said, that every kind of coal may be at once distinguished from the Torbanehill mineral by the rings contained in a well-made transverse section; and Professor Bennett maintains that such an appearance constitutes, in the majority of cases, a practical and evident test which is distinctive of genuine coal; and that, by means of it, all kinds of known coal, whether household or cannel, can at once be distinguished from the Torbanehill mineral. He affirms that every kind of coal has a distinctly woody basis, which is easily demonstrated by its longitudinal and transverse sections; that the cannel-coals have, in addition to this woody structure, a greater or less number of bituminoid marks imbedded in it; and that the Torbanehill mineral has no such woody texture, but is essentially composed of the bituminoid marks imbedded in clay.

The theory which this same Professor is disposed to put forward, as most in harmony with the various facts and arguments elicited and stated in this curious inquiry, is briefly as follows:—1st. That the various organic substances found in the sections and ashes of coal, are explicable on the supposition that coal is wood chemically altered, and for the most part, but by no means exclusively, *coniferous wood*, or wood allied to it in structure; because, from a careful comparison of recent fir-wood with the various kinds of coal, he finds the structural appearances of the cellular tissue, resin-cells, and ducts to be very similar. This assumption not only explains its structure, but accounts for the large amount of bitumen and resin or inflammable matter it contains, resin being a well-known abundant product of the coniferous tribe of plants. 2ndly. Though the Torbanehill mineral is rich in the bituminoid substance, it presents no essential traces of vegetable structure. The bituminoid or resinous matter found in the real coal, which lies in its neighbourhood, probably flowed out, mixed itself with, and solidified in the essentially earthy substance of the Torbanehill mineral. This result may have been produced by enormous pressure, conjoined with chemical changes and heat.

On the other side, Dr. Redfern, who made

numerous sections, declares that "every particle of its structure, and the fact that it is mainly composed of carbon, proves to its being a mass of vegetable matter." He pronounces it to be a variety of cannel-coal; that it resembles other cannel-coals in its geological position, in the fact that 65½ per cent. of it is carbon, in its burning like a candle when lighted at a flame (hence the original term *candle-coal*, corrupted to *cannel-coal*), and in its containing every chemical ingredient found in other coals, and none but such as exist in them. In other respects, as colour, streak, abundance of gaseous matter, it differs from other cannel-coal; but the difference is in degree, and not in kind. We have no space to say more on this very interesting mineral, which has been rendered so famous by the lawsuits it has occasioned, not only in Scotland, but, we believe, also in Rhenish Prussia; and by the difference of opinion which scientific men held respecting it, some of whom volunteered their evidence, while others were paid for it by the plaintiff and defendant respectively. This substance is now commonly termed Torbaneite, for the sake of convenience.

The wide difference of opinion respecting it does not reflect any discredit upon examinations of coal under the microscope, but rather shows that in this manner alone can any reliable knowledge of its internal structure and vegetable origin be arrived at.

Those who desire a very interesting and highly useful series of microscopic objects, cannot do better than learn to form good sections of the different coals. They are easily procurable from coal-merchants, coal-wharves, and mineralogists, and sections might be so arranged, according to their geological ages and position, as to show that there is a certain, though not, perhaps, a very definite relation between the antiquity of each kind of coal and the amount of its vegetable structure remaining, as before observed. It is not at all improbable that a careful observer would discover several features of importance for determining the origin and character of coal, and its various deposits.

J. R. Leifchild, A.M.

LEAD.

PART II.—IN THE FURNACE.

On presenting our letter of introduction at Ballycorus, no pains is spared to make us acquainted with each of the several processes conducted in the various departments of the works. First of all we are taken to the "ore houses," where the galena, as received from the mine, is stored, until it is required. Previous to its reception, however, it undergoes an examination, having especial reference to the following particulars:—Firstly, the quantity of water which a given weight contains. This is a very necessary precaution, as the amount of moisture mechanically retained by the particles of galena is often very considerable. Secondly, the per centage of lead. And thirdly, the per centage of silver. Upon the results of this estimation the value of the ore will of course depend. All these operations are conducted in the assay-office, to which we next pay a visit.

The appearance of this department is not that of an ordinary chemical laboratory, for as all the experiments made therein resemble one another in character, a much more limited stock of appliances is necessary. The apparatus consists, indeed, besides the balances, of little more than a couple of furnaces; one for cupellation, the other for smelting the

trial portions of the ore, some cast-iron crucibles, and a few test-tubes. Leaving the assay-office, we find our way into the building where the principal operation, that of smelting the ore, is performed. Its central portion is entirely occupied by a huge reverberatory furnace of peculiar construction; the chief points of difference between a lead-smelting and an ordinary furnace being, that the hearth or *sole*, upon which the ore is placed, inclines gently from all sides towards the centre like a saucer. Above the furnace is a hopper, or quadrangular funnel, through which the ore is introduced; and separated from the hearth by a bridge of refractory brick is the fire, which, all being arranged, comes sweeping as a sheet of flame over the galena. It is very important that a lead furnace should be provided with a considerable extent of horizontal passages or flues, before terminating in a chimney. Not only is this precaution based upon economical motives, seeing that part of the lead volatilizes in the form of oxide, but the sulphurous acid which is generated is extremely hurtful to both animal and vegetable life. In the present instance all the furnaces open into a flue of a mile in length, which, running up the side of the hill, terminates eighty feet above its summit.

In order to understand how it is that by merely heating galena to dull redness, we can obtain metallic lead, we must consider, in the first place, its chemical composition. This may be thus represented:—

Lead, one combining proportion			104
Sulphur	„	„	16
			120

Galena, therefore, is a protosulphide of lead. Now, when it is heated in contact with atmosphiric air, it unites with four atoms of oxygen, and from being a sulphide becomes a sulphate. We will write the composition of the sulphate also—

Lead, one combining proportion			104
Oxygen four	„	„	32
Sulphur one	„	„	16
			152

Now oxygen enters into several combinations with sulphur in different proportions, and the result of one union is sulphurous acid, or

Sulphur, one combining proportion			16
Oxygen two	„	„	16
			32

With these data, it will not be difficult to understand how it is that when 120 parts of galena (which may be either grains, pounds, or tons) are heated with 152 parts of sulphate of lead, obtained by roasting another 820 parts of galena in free contact with the air, the result will be that the 32 parts of sulphur contained in both compounds will unite with the 32 parts of oxygen contained in the sulphate to form sulphurous acid, while 208 parts of lead will be set free in the melted state.

In practical smelting, the oxidation of one-half of the galena is very ingeniously brought about. A charge of ore, usually amounting to two tons, is introduced into the furnace and the fire lighted. When the entire mass has arrived at a dull red heat, it is stirred from time to time with a long iron rake, through apertures provided for the purpose at different parts of the furnace. By this means the surface of the ore is constantly renewed, and a fresh portion exposed to the action of the atmospheric oxygen. Upon the proper management of this stage of the operation its ultimate success depends, and it is here that the practical knowledge of the smelter is most fully shown. After the lapse of a certain time, which for a charge of two tons of ore is about eight hours, the whole of the galena has become reduced to the metallic state. The furnace is then tapped, and the lead allowed to run off into an iron

well or cistern, from which it is ladled into the oblong moulds which give it the form of pig-lead.

As the galena, no matter how carefully washed, invariably contains a certain quantity of the matrix—generally quartz—with which it was allied in the natural state, a slag, consisting of this substance in the melted condition, always remains in the furnace, and is run off by a distinct opening. This slag is far from being worthless, seeing that it still retains a considerable quantity of lead, in order to extract which it is mixed with lime and subjected to the intense heat of a blast furnace. The lead thus obtained is usually much inferior to that obtained by the first operation, and is reserved for making shot—a purpose for which it is even better suited than lead which is softer and less flexile.

Galena also nearly always contains traces of other metals besides lead, but the only one of these which it is profitable to extract is silver. The proportion of this metal which remains in the lead after smelting, varies in different places between three and three hundred ounces per ton; indeed in some cases the lead is totally neglected for the sake of the silver. In the ores, however, to which the present paper relates, the most usual proportion is from five to twelve ounces.

The process by which silver is separated from lead is one which has, from time immemorial, been employed for obtaining the precious metals free from admixture with those of less value; and as we have no evidence that the process has been improved upon from the time of Moses up to our own, the belief in a much more advanced state of chemical knowledge than is generally supposed to have existed at so early a period is considerably strengthened. The separation of silver by what is termed cupellation, is based upon the circumstance, that metallic lead enters into combination with oxygen at a red heat, and that silver does not. Now, if an alloy of these two metals be melted in a vessel made of some porous substance, and a strong current of air be made to pass over the melted mass, the lead alone will be oxidized, and litharge or protoxide of lead will be formed, which will be absorbed into the porous substance, and leave the metallic silver unalloyed upon its surface. Now when lead contained only a very small per centage of silver, a tedious process like this, and one, moreover, which required a large expenditure of fuel, would be manifestly unprofitable, were the litharge wasted. But it is not, for, besides having a market value of itself, the lead can be recovered from it by smelting with coal, the carbon of which unites with its oxygen, and liberates the metal. Even as it was, the silver obtained from most ores would not have paid the expense of extraction, and would have been most likely altogether neglected, were it not that the presence of a very small per centage of this metal renders lead hard and brittle, and unfits it for many purposes to which it is applied. Its extraction, therefore, even when there was but a little present, was a necessity.

This state of things continued up to the year 1829, when the late Mr. Hugh Lee Pattison, of Newcastle-upon-Tyne, devised the ingenious process which bears his name. Mr. Pattison discovered that when a melted alloy of lead and silver—even though the latter metal should only be present in the proportion of a single ounce to the ton, was allowed to cool slowly, it appeared to separate into two portions, one of which took the crystalline form, and fell to the bottom of the melting pot; while the other remained fluid. An examination of these two portions showed him that the portion which solidified was nearly free from silver, which all remained in the fluid part. Upon this discovery he based a method of *desilverizing*, which annually adds many thousand ounces to our supply of this valuable metal, and improves the quality and lessens the price of lead. In illustration

of this saving, the following figures may be given. Let us set out with lead, containing 10 ounces of silver to the ton. Now, formerly, 30 tons of such lead would have to be cupelled in order to obtain 300 ounces of silver, while by Pattison's process the whole 300 ounces is concentrated in one ton of lead, which alone undergoes cupellation, and the remaining 29 tons have only to be remelted, and sent into commerce as pure lead.

To see this wonderful application of scientific knowledge in full operation, we enter a lofty building, open at either end, in which are ranged a series of eight cast-iron cauldrons, set in brick fire-places. Each of these is capable of containing ten tons of metal, which is the pig-lead from the smelting furnace. When the whole mass is melted, the fire is reduced to a degree, which will just keep the lead a little below the melting point. A very gradual process of cooling is, therefore, taking place. It so happens that there is but one of the pots being worked when we enter, so that we run no risk of failing to understand what is going on. First of all, then, there is the man who keeps incessantly stirring the molten mass, until he feels, by the resistance to the iron paddle with which he works, that a quantity of lead crystals have collected at the bottom of the pot. Then he takes an immense perforated ladle, and crushing the blue film upon the surface of the leaden sea, it sinks slowly into its depths. A chain is now attached to the handle, and the other end being made fast to the windlass—the fulcrum of this long lever being the edge of the melting pot—a few quick turns bring the ladle up, almost bending under the weight of its burden, while through the perforations the enriched lead falls in, literally, a silvery shower. But as the lead crystals still retain melted metal in their interstices, the workman again and again shakes the ladle, until not a drop more will come from it. The crystals, which are granular and agglomerated by fusion, so as to resemble a dull gray sandstone, are passed into another pot, where they are, with a new supply, subjected to a repetition of the operation, while the enriched lead is further treated in the same manner, until it contains about 300 ounces of silver in a ton. Further than this it is not found profitable to go. This, then, is Pattison's desilvering process, founded upon what but for his genius might have been, if known at all, merely a scientific abstraction.

The Pattisonized lead, now rich in silver, is handed over to the refiner. Unfortunately, we cannot follow it through the very interesting process of cupellation, for this is only performed at Ballycorus when a sufficient quantity of the alloy has been accumulated to yield a cake of silver of some 6000 ounces. We can, however, inspect the furnace, and get some idea of how it is performed upon so large a scale.

The hearth of the furnace is so constructed as to admit of the cupel, or "test," being placed upon it. This is a flat dish, about two feet long by eighteen inches wide, and is made by pressing into an iron grating, which forms at the same time a model and a support, a quantity of a paste made of finely ground bone-ashes mixed with water. Now, not far from the cupel, and communicating with it by means of a narrow channel cut in the setting of the furnace, is a small melting pot. Matters are so ordered, that the pot being full of melted metal, some of it shall run into the cupel. The fire is now urged to its greatest intensity, and a strong blast of air being established by means of a fan, the lead becomes rapidly oxidized, and the metal oxide floating upon its surface is swept off by the current of air, much as you would blow the froth from a glass of champagne, and falls into a pot placed to receive it. And could we see all this, a still more interesting sight would await us at the close of the operation, when the last vestiges of the lead were passing away. Up to this time the surface of

the lead appears infinitely brighter than the surrounding furnace, a result which is due to the intense heat produced by oxidation. Suddenly, as less oxidizable metal remains, the surface becomes dull, when, with lightning-like rapidity, there is another change. The gradually thinning film of oxide presents a quick succession of prismatic colours, until presently, as a rainbow fades from a sunlit lake, it breaks, and the bright sheet of silver comes into view. Twenty tons of lead are usually cupelled at one operation, and, consequently, the cake of silver produced weighs about 6000 ounces.

Before we bid farewell to lead, let us visit yonder tower upon the hill, and see how shot are made. But, first of all, there is a certain furnace at which we must glance. It is in a building which adjoins the cupelling house, and close beside it lies a large heap of a heavy white powder. There are also some pigs of lead, which are of a darker colour than any which we have yet seen; when you strike them, they make a sharp ringing sound. These pigs are the lead from the slag, or scoria, which, as we saw just now, is reserved for shot-making, seeing that it is almost worthless for any other purpose. The white powder is arsenious acid—the white arsenic of the shops. What is this for? If you melt lead, and pour it into water through a metal sieve, it will form a number of irregularly-shaped masses, not at all globular, or even ellipsoid. But if you try the same experiment with lead to which a little arsenic has been added, the drops on cooling will be nearly perfectly spherical. The arsenic is added to the melted lead in a very small proportion, not more than from seven to ten parts to one thousand, and its oxygen uniting with some of the lead, forms litharge, which floats at the top, while the liberated arsenic forms an alloy with the remainder of the metal. This alloy of lead and arsenic, or, as it is technically called, "poisoned metal," is next taken to the shot-tower, where it is remelted and poured from the summit through perforated metal plates, or "cards," as they are called. It falls into a vessel of water placed to receive it, and the subsequent operations which the drops have to undergo, before they find their way into the shot-belt of the sportsman, are but few and simple. They comprise the assortment of the drops into various sizes, the removal of such as are not perfectly spherical, and the polishing by means of plumbago.

HARRY NAPIER DRAPER, F.C.S.

A MERIDIAN-LINE.

To possess some independent means of obtaining the true time, whereby a person may, in his own house, ascertain the error of his clock or watch to within a second or two, is so obvious a *desideratum*, that all readers of RECREATIVE SCIENCE, who do not at present possess the means, will, doubtless, be pleased to have their attention directed to a simple method by which so desirable a result may be obtained.

The transit-instrument, the *sine qua non* of observatories, is, doubtless, the best for the purpose. It is, however, rather an expensive instrument, and for accurate purposes requires frequent and careful adjustment.

The sun-dial is too rough a method. By it the time can hardly be obtained nearer than to within a minute of the truth. There are other methods, many of which are inte-

resting to those who have leisure to investigate them. We propose to confine our attention, in this article, to a *meridian-line;* by which the time may be obtained to within two or three seconds, and which may be of very great use to amateurs in astronomy, etc.

The meridian-line is a very old method of determining by a fixed mark, or set of marks, the time of the sun's passing the meridian of the place. There is a description of one in "Ferguson's Lectures" (1793, 8th edition, p. 375). Probably other works also contain notices of similar methods. We are not aware, however, that any one is so useful as the one proposed to be described, which appears to us to combine the chief advantages of all the others with which we are acquainted, while it also has some which are original.

We preface our description by the remark that the meridian-line is not self-checking (so to speak) as the transit-instrument is. Its position must be checked by *other* means, but when once proved, it may then be regarded as a fixed line of reference, by which to ascertain the time of the sun's passing the meridian.

We will suppose two classes of observers, who may be interested in pursuing this subject. The first we will suppose to be able to calculate the error of the clock or watch by taking a set, or sets, of altitudes—single or double—with the sextant. To do this requires some knowledge of trigonometry, and the use of logarithms. This class of persons will, of course, have no difficulty in at once getting the time approximately, in order to fix the line nearly in its position; and afterwards, by a series of approximations, determine its final place. The other class we will suppose to be ignorant of the trigonometrical modes of obtaining the time. Such persons may, notwithstanding, be fully competent to *use* the meridian-line when once its position has been carefully determined. The former class can *prove* at any time how nearly the line is in the plane of the meridian. The latter class must put *faith* in some one who is competent to ascertain the time *for them*, and get such an individual to furnish them with the true time in the first instance. They may then themselves fix their line once for all, according to the directions hereafter given; bearing in mind the fact, that when once properly fixed, the line may be regarded, for all rough astronomical purposes, as a final reference, and an independent means of checking the clock from day to day, or week to week, etc.

The mode is as follows:—

Get a plate of brass or copper of the size say 6 inches by 3, and about 1-16th of an inch thick. File a clean hole towards one end of it, say 1 inch long by 1-8th broad; the metal to be fixed so that the hole shall have the long sides vertical. This piece of metal is to be fixed very securely to the upper stonework outside a window having a southerly aspect—not necessarily *opposite* the south; my window, where such a line is fixed, for instance, faces about S.S.E. Get the local time approximately, as above referred to, say to about one minute of the truth, in order to ascertain *about* where to fix a piece of wood, from which a plumb-line is to be suspended, of moderately thick silk or cotton, waiting, of course, till the sun is in the meridian, as nearly as the watch or clock at present can give it.

Having made a mark on the ceiling, fix a piece of wood firmly to the joists, and on this fasten another piece; mahogany, or other hardish wood. The latter must be shaped something like the top of the capital letter T, to admit of a wire, copper or brass—with a carefully filed or turned groove in it, to which the plumb-line is to be fixed—being placed through the ears of the T, at right angles to the meridian, and made to move east or west, and "friction-tight," for adjustment. The piece of wood fixed to the *joists* must be at such a distance from the window as will allow

the sun to shine, at his southing, through the hole outside, on the plumb-line, throughout the year. Having fixed the plumb-line approximately, by observing the sun when he is about south—of course not forgetting the equation of time—the next thing is to get a small wooden pillar, the height of the room, with a vertical slit in it, or a set of holes, to enable the observer to see a second plumb-line, also in the plane of the meridian, which he should attach to the ceiling some feet further from the window than the principal one. The object of the second plumb-line is to enable the observer to avoid parallax between the plumb-line and the slide (referred to hereafter), by enabling him to keep the eye in the plane of the meridian when setting the slide.

During the observation, it must be remembered that the observer sits or stands with his *back* to the sun. A little wooden box must now be used, open on two opposite sides, to enable it to slide up and down the pillar, to suit the sun's altitude at the different times of the year. The box should have a "set-screw" on one side, and a dovetailed groove on the *south* side, in which is to slide horizontally a piece of wood on which is pasted white paper to receive the beam of light coming through the slit, and also for the graduations by which the central observation is to be checked.

The pillar must be so placed to the *north* of the principal plumb-line—the one close to the pillar—that the plumb-line may hang about 1-10th of an inch to the south of the outside vertical face of the sliding piece of wood. Two vertical lines should now be drawn on the prepared face of the slide, at a distance from one end of it say of about one-third of the length of the slide, which should be six or eight inches long, the vertical lines to be sufficiently far apart to suit the average width of the beam of light coming through the slit in the metal outside, at the different periods of the year. The space included between these two lines should be bisected by a third line parallel to the others, the use of the last being for the central observation of the passage of the beam of light across the meridian line, or plane.

Other vertical lines may now be drawn on one side only of the central space, at distances to suit the observer's convenience, the use of them being to enable him to get *pairs* of observations, composed of those before and after the sun's passing the centre; by taking the *means* of these, after reversing the slide, he will be able to check the central one.*

We will now suppose the observer to have completed his arrangements for taking the observation. Having ascertained the position which the beam of light will occupy, with the given declination for the day, he stands or sits with his back to the sun, having darkened the room if he is desirous of getting a better defined image of the sun. The slide being arranged so as to move easily by the hand, or by means of a *screw* (which would be an improvement on the plan we have been accustomed to adopt), the observer places the slide so that one of the vertical lines shall be in the plane of the meridian, and he now waits, watch in hand, till the beam of light gets to the space marked out for it.

The lines should be numbered 1, 2, 3, etc. The instant when the beam of light occupies the centre of the space alluded to being noted, the slide is quickly pushed forward, from left to right, till the next line is in the plane of the meridian. So on till the sun arrives at the meridian. The central observation is then taken. The slide is now reversed, so that the very same lines are used after noon as before noon; and thus no error can arise from graduation. By this method, which is original, the near approach towards the truth

* The application of the principle of pairs of observations to the meridian line, as well as many other advantages which the line now described affords, should be placed to the credit of Mr. Bunt, the well-known tide-computer, etc., who suggested many original ideas in reference to it.

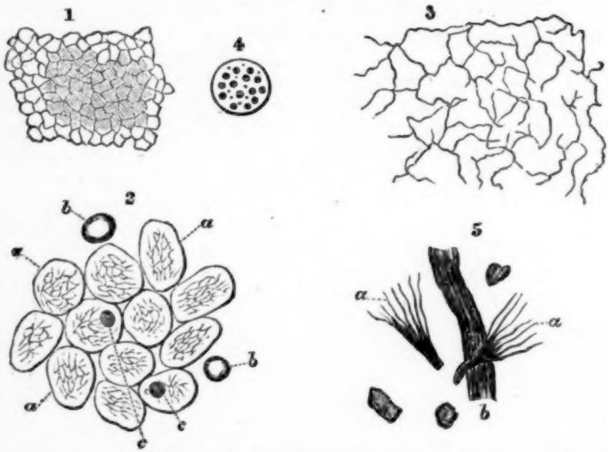
which may be obtained, is surprising. I have made scores of comparisons between the time so obtained, and that obtained by the transit-instrument, and the agreement between the two results is far nearer than would be expected from apparently so rude a method.

WILLIAM C. BURDER.

Observatory, South Parade, Clifton, Bristol.

THE VEGETATION OF A DECAYED NUT.

A FEW days since, being employed in the agreeable occupation of eating brazil-nuts, I found one which, though it afforded no pabulum for the material appetite, at least furnished food for the mind. It was a decayed nut, the whole of the kernel being completely decomposed, and in the place of the solid, white, oily kernel, proper to the interior of the shell, a few particles of oily, sugary matter was found. This led me into a train of reflection, and the determination succeeded to submit it to the test of that wonder revealing instrument, the microscope.



Thinking that it would be necessary to know the component parts of a healthy nut, I first procured a portion of the brown scaly covering with which the nut is invested. This was, as I expected, an epidermis of simple membrane, covering the albuminous matter composing the kernel. When placed in a drop of water, and viewed with a power of 500 diameters, it was seen to be distinctly cellular in appearance, the cell markings closely assimilating to those of the flattened scales of the human skin. Hence I concluded it was made up of flattened cells. Viewed with oblique light, its markings were distinctly seen. Fig. 1 gives a good idea of them. I next made a very thin section of the kernel, and found it to be cellular in structure, exhibiting well defined cell-walls, composed of a tough, rather opaque membrane, in shape somewhat oval (Fig. 2). Here and there were seen in the field of view globules of oil, with their well-defined rings (Fig. 2, *b*), produced by the unequal refraction of the light.

Several sections were made horizontal, vertical, and diagonal, with the same result, each showing cells with thick walls, and in a few cells a central nucleus (Fig. 2, *c*). Viewed with oblique light, the membranous coating of the cell is beautifully seen. When compressed between the compressorium, or two plates of glass, a rupture of the cell-wall is effected, and a drop of water, or glycerine (glycerine answers best, from its greater refractive power), being placed on the slide, the contents of the cell are floated out, and appear to be granules variously shaped. I neglected to test for starch, but doubtless, from the analogy of the nut, they would be found to be principally composed of that substance. Having proceeded thus far in my researches in the healthy nut, and learned thus much of its organization, I proceeded to the examination of the diseased specimen.

The diseased nut was apparently affected with a malady, which had consumed it, and it was no longer a very agreeable subject to investigate, but the student of natural history must not sicken at an unpleasant smell, or shrink from an occasional disagreeable sight; such will sometimes afford him the best means of instruction. Reasoning from the fœtid odour of the decayed nut, nitrogen entered into its composition. The appearance of the shell was as if it had been soaked in oil, doubtless owing to the oily matter from the cells of the nut being set at liberty, and decomposition producing heat, thus rendering the oil more liquid, and enabling it to permeate through the walls of the shell. The kernel was entirely decayed, no trace of cell being visible, nothing remaining but a soft, oily, sugary mass, of a dirty yellow colour; the epidermis was thinner than in a healthy specimen, but exhibiting the same markings. My first care was to remove a small portion of the dirty yellow matter; this was placed under the microscope, with a power of 300 diameters, and there stood revealed a reticulation of thread-like fibres, beautiful in their confusion; they were interlaced in every direction, a mere mass of fungi, the result, probably, of some errant spore released from its parent stem, where it had hitherto nestled under the tropical sun of Brazil, until having arrived at a period when it became necessary to procure its own subsistence, it started on its voyage of life, and wandered along on the wings of the gentle breeze until at length it found a resting-place within this yet unripe nut. Here it grew with its growth and fattened upon its decay; not a trace of cell was visible, nothing but the threads ramifying in every conceivable direction (Fig. 3). The specimen was treated with various chemical reagents, but nothing showed the structure more distinctly than being merely mounted dry, and covered with thin glass. When viewed with oblique light, only a small pencil of rays being permitted to fall upon the fibres, they were found to be hollow tubes, exceedingly delicate in appearance, but in reality very tough and tenacious. Here and there were to be seen small globular bodies of what I conceived to be sporidia; one particularly engaged my attention, as it rolled gently over the field of the microscope, it was studded with minute points, darker in colour than the surrounding mass (Fig. 4). Another specimen was examined, not quite so much decayed as the first; the same thread-like fibres were to be seen, but with a different configuration (Fig. 5, *a*), and, crossing the field was a dark brown line of vascular tissue (Fig. 5, *b*). Probably owing to its greater density in structure, it was enabled to resist the parasitic fungi which had destroyed so much around it.

Here, then, was a lesson taught and reflections suggested by a very simple subject, combined with the power of observation. How many would have thrown it aside, disgusted with its unpleasant odour, without a thought that, disagreeable as it was, it yet contained within it a vast mass of vegetable life, supported by the same means, and

fashioned by the same Almighty hand that formed the wonderful complex organs of man himself. The thought was conceived, was the fungus the cause or the effect of the disease? What a wide field for inquiry was opened by this decayed nut, what happiness to look, as it were, into some of the mysteries of God's work, and see and know that nothing is made in vain; that the decay of one plant or animal furnishes food for others, until at length animal, plant, and parasite yield to the Almighty fiat, and return to their kindred dust, and even in their last act affording means of subsistence to a new race more highly developed.

W. F. Cooper.

METEOROLOGY OF MAY.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

—o—

Year.	Greatest Heat. Degrees.	Greatest Cold. Degrees.	Range of Temperature.	Amount of Rain. Inches.
1842	67·0	38·0	29·0	—
1843	67·0	26·0	41·0	3·1
1844	74·5	34·0	40·5	0·5
1845	69·0	37·0	32·0	3·3
1846	81·4	40·0	41·4	0·7
1847	84·5	35·0	49·5	5·0
1848	83·0	35·3	47·7	1·4
1849	75·2	31·8	43·4	2·4
1850	79·2	31·2	48·0	1·3
1851	77·0	31·0	46·0	1·3
1852	79·0	32·0	47·0	1·1
1853	82·0	30·4	51·6	1·0
1854	73·0	31·4	41·6	2·2
1855	81·9	26·8	55·1	1·9
1856	70·8	30·9	39·9	3·8
1857	72·8	30·0	42·8	1·0
1858	84·0	30·9	53·1	1·4
1859	78·5	30·8	47·7	0·5

The greatest heat in the shade reached 84·5° in 1847, and 84° in 1858, and only 67·0° in 1842 and 1843, giving a range of 17·5° in greatest heat for May during the last eighteen years. The temperature rose above 80° in 1846, 1847, 1848, 1853, 1855, and 1858, and did not reach 70° in 1842, 1843, and 1845.

The greatest cold was as low as 26·0° in 1843, and 26·8° in 1855, and never below 40·0° in 1846, giving a range of 14·0° for greatest cold in May during the last eighteen years. The temperature did not descend to the freezing point in 1842, 1844, 1845, 1846, 1847, and 1848, since which year there have been frosts every May, the coldest years being 1843, 1853, 1855, and 1857.

The range of temperature in May was as much as 55·1° in 1855, and as little as 29·0° in 1842.

Only half an inch of rain fell in 1844 and 1859, and as much as 5 inches in 1847, giving a range of 4·5 inches for May during the past seventeen years. In fourteen years the fall exceeded an inch, and in six years it exceeded two inches; the mean amount for May being 1·8 inches.

E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR MAY, 1860.

—o—

The Sun remains in the constellation Taurus until the 20th, when he moves into Gemini. He rises in London on the 10th at 4h. 18m., on the 20th at 4h. 3m., and on the 31st at 3h. 51m., being forty-three minutes earlier on the last day than on the first. He sets in London on the 10th at 7h. 36m., on the 20th at 7h. 50m., and on the 31st at 8h. 4m. p.m., or forty-three minutes later on the last than on the first day. In the middle of the month, he rises at Dublin nine minutes earlier than in London. At Edinburgh, in the middle of the month, he rises twenty-one minutes earlier, and sets twenty-two minutes later than in London, there being in Edinburgh 16 hours and 19 minutes of sunlight, and in London 15 hours and 37 minutes.

The sun reaches the meridian on the 10th at 11h. 56m. 11s.; on the 20th at 11h. 56m. 17s.; and on the 31st at 11h. 57m. 25s.

The equation of time on the 10th is 3m. 49s.; and on the 31st, 2m. 35s. after the Sun, and consequently subtractive.

Day breaks on the 11th at 1h. 24m., and on the 21st at 0h. 28m.

Twilight ends on the 11th at 10h. 31m., and on the 19th at 11h. 17m.

Length of day on the 2nd, 14h. 51m., and on the 16th, 15h. 37m.

On the 3rd, no night at Edinburgh, and on the 23rd no night in London.

The moon is full on the 5th at 7h. 2m. a.m.

New moon on the 20th, at 6h. 46m. p.m.

The moon is nearest to the earth on the 2nd and 29th, and furthest removed from us on the 14th.

Mercury is a morning star, and favourably situated for observation. During the month he passes from the constellation Pisces to Aries, and finally into Taurus, being slightly north of the Hyades at the close of the month. He rises on the 1st at 4h. 1m. a.m., on the 10th at 3h. 46m. a.m., on the 20th at 3h. 32m., and on the 30th at 3h. 29m. a.m.; setting on the 1st at 4h. 39m. p.m., on the 21st at 6h. 4m., and on the 31st at 7h. 14m. p.m.

Venus is a splendid object in the western sky during the evening. On the 11th she will be of the form of a half-moon, and have a diameter of nearly 24″, intensely white in colour, and casting strong shadows in the absence of the moon. She is in Tau-

rus, passing into Gemini, reaching her greatest eastern elongation on the 9th; rising on the 1st at 6h. 26m. a.m., on the 16th at 6h. 34m., and on the 31st at 6h. 45m. a.m.; setting on the 1st at 11h. 46m. p.m., on the 16th at 11h. 48m. p.m., and on the 31st at 11h. 27m. p.m.

Mars is unfavourably situated for observation; he is in Sagittarius. He rises on the 1st at 12h. 52m. a.m., on the 16th at 12h. 17m. a.m., and on the 31st at 11h. 33m. p.m.; setting on the 1st at 8h. 40m. a.m., on the 16th at 8h. 6m. a.m., and on the 31st at 7h. 24m. a.m.

Jupiter is a very fine object, although much less conspicuous than Venus. He is an evening star. He is in Gemini until the end of the month, when he passes into Cancer. He rises on the 1st at 8h. 35m. a.m., on the 16th at 7h. 48m., and on the 31st at 7h. 2m. a.m.; setting on the 1st at 12h. 57m. a.m., on the 16th at 12h. 5m. a.m., and on the 31st at 11h. 12m. p.m. He occults the Moon on the 24th.

Saturn is still an evening star, in the constellation Leo, rising on the 1st at 11h. 19m. a.m., on the 16th at 10h. 23m., and on the 31st at 9h. 28m. a.m.; setting on the 1st at 2h. 23m. a.m., on the 16th at 1h. 25m. a.m., and on the 31st at 12h. 28m. a.m. He is a conspicuous object, and situated near Regulus.

Uranus is now invisible to the naked eye, being too near the Sun, in the constellation Taurus; rising on the 1st at 5h. 37m. a.m., on the 16th at 4h. 41m. a.m., and on the 31st at 3h. 45m. a.m.; setting on the 1st at 9h. 41m. p.m., on the 16th at 8h. 47m. p.m., and on the 31st at 7h. 53m. p.m.

Vulcan.—The Intra-Mercurial planet has received the name of Vulcan.

Occultations of Stars by the Moon:—There are none larger than the $5\frac{1}{2}$ magnitude during the month. Jupiter, however, will pass behind the Moon on the 24th, disappearing in London at 4h. 34m. p.m. in the centre of the Moon on its unenlightened side, and reappearing at 5h. 47m. p.m. near the centre of the enlightened side.

Eclipses of Jupiter's Satellites:—On the 14th, at 8h. 50m. 10s. p.m., 3rd moon will disappear. On the 17th, at 10h. 15m. 27s. p.m., 1st moon will reappear.

E. J. Lowe.

THINGS OF THE SEASON—MAY.

FOR VARIOUS LOCALITIES OF GREAT BRITAIN.

—o—

Birds Arriving.—Sedge Warbler, Reed Warbler, Fern Owl, Field Titlark, Razor Bill, Dottrell, Hobby, Red-backed Shrike, Spotted Flycatcher, Land Rail.

Birds Departing.—Bean-goose.

Insects.—Carabus monilis and nitens, May Chaffer, Cicindella hybrida, Bombardier, Agonum marginatum, Colymbetes abbreviatis, Gyrinus bicolor and villosus, Necrophorus species, Onthophilus species, Dor Beetle, Scoltus destructor, Donacia dentipes and simplex, Mordella aculeata, Phyllobius argentatus, Deporans betulæ, Swallow-tail, Cabbage Green-veined White, Green chequered Wood White, Orange-tip White, Chequered, Grizzled, Dingy, and Large Skipper, Common Blue, Clifden Blue, Pearl Bordered Likeness, May, Marsh, Pearl Bordered, and Queen of Spain's Fritillary, Bedford Blue, Mazarine Blue, Unicorn Beetle, Burnet Moth, Eyed Hawk-moth, Lime Hawk-moth, Bee Hawk-moth, Ghost Moth, Goat Moth, Puss Moth, Fox-coloured Moth, Large and Buff-spotted Ermine, Cinnabar Moth, Button Snout, Spotted Muslin, Cassida nobilis and splendidula, Staphylinus pubescens.

Wild Plants.—Germander Speedwell, Sweet-scented Vernal, Wood Melic, Common Quaking, Woodruff, Great Plantain, Barren Wort, Water Scorpion Grass, Alkanet, Comfrey, Yellow Mountain Violet, Periwinkle, Goosefoot, Wood Sanicle, Snow-flake, Poet's Narciss, Harebell Squill, Solomon's Seal, Herb Paris, Alpine Saxifrage, Mossy Saxifrage, Wood Sorrel, Bladder Campion, Wood Strawberry, Common Avens, Celandine, Pheasant's Eye, Water Crowfoot, Globe Flower, Dead Nettle, Toad Flax, Linnæa, Hedge Mustard, Wild Mustard, Cardamine, Shining Crane's-bill, Robert Crane's-bill, Jagged-headed Crane's-bill, Common Mallow, Heath Pea, Bird's-foot Trefoil, Black Vetch, Grass Vetch, Meadow and Woodside Orchids, various, Briony, Crowberry, Mistletoe, Sweet-gale.

Mr. Noteworthy's Corner.

Naturalist's Telescope.—In page 36 of Recreative Science, Mr. Noteworthy remarks that a telescope with a short range would be very useful in observing the habits of birds, etc. I think some of your readers might find one of a kind I have for some years used to be very serviceable. It is of about twelve diameters' magnifying power (nearly 150 area), with focus from distant range to within two yards of the observer, covered with black leather, to prevent the glare of the sun. The one I use was made by Mr. Bryson, optician, Princes Street, Edinburgh, at a cost of about thirty shillings. He has them at less, or greater prices, ranging with the magnifying power. Many most interesting sights are within the range of such a glass, which are unseen by an observer without one whose approach frightens away the animal. Just the other day I found its use; for, happening to have it with me, I saw the first butterfly I had this year seen. It was at some distance, and seemed either a white or sulphur, and disappeared near a tall holly-tree. Coming to the place, nothing was to be seen to the unaided eye; a few stones sent into the tree produced no effect. If it were a common white I did not want it, but if a sulphur, I did; and so I pulled out my glass, and took a close survey of the tree, branch by branch. At last I found him clinging to the under side of a branch, where he had hoped to escape unseen, and would have done, but for this glass. So having found him, I made out by his angle wings that it was worth my while to get him, and soon he was

dislodged, and reposing in my chloroform bottle. Every day I find its use, so think your readers could not do better than get one. I may say that in manufacture and optical exactness they are most satisfactory instruments.—C. HOPE ROBERTSON.

OCCULTATIONS OF JUPITER'S SATELLITES.—"An Inquirer" wishes to know how it is that a satellite of Jupiter is made to reappear on several different dates without an intermediate disappearance, or *vice versa*. After a satellite has disappeared behind the planet, it must of course emerge again before it can disappear a second time; but, unless the reappearance takes place whilst Jupiter is visible, it is omitted in the list of occultations as unnecessary information.

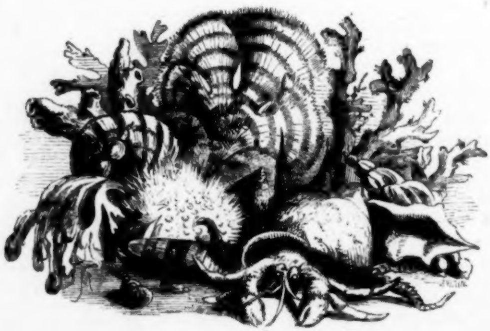
CELESTIAL OBJECTS.—It is worthy of note, that during March Venus has been seen in the day with the naked eye as early as half-past four o'clock, and that on the 23rd, at 6h. 45m. p.m., the young Moon was visible at Warren Point, Ireland, although new Moon had only occurred at 1h. 56m. p.m. on the 22nd.

BIOLOGICAL TERMS.—A learned TINKER asks to "make a note on what may be called a plausible misuse of the word 'eliminate,' on page 175. It is true it means, 'to throw out,' and, therefore, may be said to be correctly used to describe colours thus appearing by rotation, but the real sense of the word is, to cast out something superfluous or noxious, or not *apropos* to what we seek to produce or educe, one of which latter two words should be used in the passage referred to."

ELECTRIC ILLUMINATION.—Mr. Faraday, in his lecture on "Light-house Illumination," at the Royal Institution, spoke in the highest terms of praise of the efficiency of the apparatus in use at the South Foreland High Light. This was placed in the lighthouse by Professor Holmes, to do duty for the six winter months. There are two magneto-electric machines at the South Foreland, each being put in motion by a two-horse power steam-engine; and, excepting wear and tear, the whole consumption of material to produce the light is the coke and water required to raise steam for the engines and carbon points for the lamp in the lantern. The lamp is a delicate arrangement of machinery, holding the two carbons between which the electric light exists, and regulating their adjustment; so that whilst they gradually consume away, the place of the light shall not be altered. The electric wires end in the two bars of a small railway, and upon these the lamp stands. When the carbons of a lamp are nearly gone, that lamp is lifted off, and another instantly pushed into its place. The machines and lamp have done their duty during the past six months in a real and practical manner. The light has never gone out through any deficiency or cause in the engine and machine-house, and when it has become extinguished in the lantern, a single touch of the keeper's hand has set it shining as bright as ever. The light shone up and down the Channel, and across into France, with a power far surpassing that of any other fixed light within sight or anywhere existent. The next step will be to adopt this light for the illumination of towns, and in London one such experiment begins to promise a complete success.

A NEW PLANET, the first of the year 1860, but the 58th of the series of planetoids, was detected by M. Luther, at Bilk, near Düsseldorf, on the evening of Saturday, March 24. The following positions were obtained by the discoverer the same night:—

	B. M. T.	R. A.	Decl. N.
March 24 ..	11h. 0m. ..	12h. 1m. 56s. ..	2° 51′
" 24 ..	12h. 14m. ..	12h. 1m. 53s. ..	2° 51·5′



INDEX

END OF THE FIRST VOLUME.

LONDON:
THOMAS HARRILD, PRINTER, SALISBURY SQUARE,
FLEET STREET.